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Contents

EDITORIALS

	PAGE
Discussions of Committee Reports	653
The Value of a Great Association	653
See the Installation of Car Retarders	653
A Great Railway Man	654
Is a Four Day Session Coming?	654

MISCELLANEOUS

Conventionalities	655
Large Attendance at A. R. E. A. Meeting	656
Address of President J. M. R. Fairbairn	656
Report of the Secretary	658
A. R. E. A. Registration	687
Western Society Meeting	691
Second Day of Signal Meeting	692
Signal Section Elects New Officers	707
Signal Section Registration	708

A. R. E. A. PROCEEDINGS

Report on Iron and Steel Structures	659
Report on Economics of Railway Location	661
Report of Committee on Electricity	663
Report on Rules and Organization	666
Report on Shops and Locomotive Terminals	670
Report of Committee on Ballast	674
Report of the Committee on Water Service	677
Report on Records and Accounts	683

SIGNAL SECTION PROCEEDINGS

Report of Committee V—Instructions	692
The Aim of Technical Education, by E. H. Freeman	695
Report of Committee III—Power Interlocking	697
Report of Committee XI—Chemicals	699
Report of Committee IV—D. C. Signaling	700
Report of Committee VI—Designs	702
Joint Report on Fouling Protection	703
Report of Committee VIII—A. C. Signaling	704
Lightning Protection on Low Voltage Lines	706

NEW DEVICES

A New Protected Metal Smoke Jack	708
Turbo-Generator Designed for Train Control Application	709
Zenith Reinforced Shovel	710
A New Protective Coating for Steel	710
Air Lift "Air Made" Well	711
New Magneto Drive for Locomotive Tachometer	712

Discussions of Committee Reports

WHILE there is widespread recognition of the value of the large amount of information presented in the reports of the various committees, it must also be recognized that the length of these reports makes it difficult to allow sufficient time for full discussion on the floor of the convention, with the result that many members hesitate to present their views, knowing the pressure on the presiding officer to carry the program through on schedule. The recommendation of the Association that members prepare in advance their discussions on the topics in which they are interested will tend to eliminate much lost motion but will not ease the situation entirely, since much constructive discussion is called forth by the remarks of others on the subject. The danger exists that the reports of the committees will be endorsed in a perfunctory manner. No one questions the fitness of the committees selected to report on the various subjects assigned them, or belittles the serious attention and the large amount of time they devote to committee work. Nevertheless, there are many honest differences of opinion as to many conclusions presented and it is important that opportunity be given for a full discussion before the Association goes on record as to their adoption or rejection, to the end that the action taken may reflect the well-considered opinions of the members.

The Value of a Great Association

IT is interesting, when the A. R. E. A. convention is in session, to reflect upon the extent to which the wisdom with which the huge annual capital expenditures of the railways are made is determined by the men in the meeting room. The permanent property of the railways—not including land—represents about two-thirds of their investment, or, say, a total of around sixteen billion dollars. This vast investment has been made under the immediate direction of the engineering officers, and largely as a result of their studies and recommendations. When, as at present, the annual investment in property being made by the railways is about 800 million dollars annually, it is probable the amount of it made on the recommendation and under the direction of the engineering officers is approximately a half billion dollars. On the way in which investment in the permanent properties is made very largely depends the efficiency and economy with which operation can be carried on. In addition to these huge capital expenditures, the engineering and maintenance of way officers are largely responsible for the results secured from the outlay of about $800,000,000, which is spent annually for maintenance of way and structures. These figures emphasize not only the importance of the work of the engineering and maintenance of way officers, but also the importance of the reports, discussions and conclusions of their annual conventions. It is purely a matter of conjecture what the 26 years' work of the A. R. E. A. and its committees has saved the railways and the public, but it seems not at all improbable that it has amounted, not merely to millions, but to hundreds of millions of dollars.

See the Installation of Car Retarders

IT is fortunate that those in attendance at the annual conventions of the American Railway Engineering Association and the Signal section of the American Railway Association have the opportunity to inspect installations of car retarder systems on the two humps of the Markham classification yard of the Illinois Central near Chicago. The development of car retarder systems in the United States has been rapid in point of time. Within the last two years the Indiana Harbor Belt Line, starting with only an idea of its vice-president, George Hannauer, produced a practical system of electro-pneu-

matic car retarders at the Gibson (Ind.) yard. This development was taken over by the two principal signal manufacturers, and within the last few weeks the first all-electric car retarder system, as developed by the General Railway Signal Company, was placed in service at the classification yard of the Illinois Central at East St. Louis, Ill., and on Monday of this week the electropneumatic system, as manufactured by the Union Switch & Signal Company, was placed in service on the northbound hump of the Markham yard of the same road near Chicago, while the southbound hump, equipped with the all-electric system of the General Company, will be ready for service within a few days. The installation of car retarders in a classification yard involves not only signaling but also engineering problems. For example, the East St. Louis hump was reconstructed so that there will be no acceleration of cars after leaving the last retarder. Mechanical humps can be adjusted to give a different acceleration to compensate for weather conditions, and insure a uniform acceleration of the cars at all times. The Markham yard at Chicago is an entirely new facility, not only in the layout of the yard but in the special equipment of the car retarder systems. Many engineering and signal officers are planning to make the best of this unusual opportunity to inspect this installation, the latest development in railway switching facilities, during the next few days. Because of its novelty and accessibility from Chicago as well as its practical importance the installation is properly to be considered among the attractions of the convention.

A Great Railway Man

IT WILL be the privilege of those attending tonight the annual dinner of the American Railway Engineering Association to hear an address by a great railway man who has had a career which, while one of steady progress, has been in some respects romantic. We anticipate that one comment that will be made by many who are not familiar with the appearance and career of the president of the Canadian Pacific will be regarding his youthful appearance. The main reason why his appearance is youthful is that Mr. Beatty, although he has been for several years the executive head of one of the greatest and most efficiently managed transportation systems in the world, really is still a young man. Edward Wentworth Beatty is a Canadian by birth and a fine example of that considerable number of American railway executives who have come up through the law department. He entered the service of the Canadian Pacific in 1901 when he was 24 years old. He became general solicitor when he was less than 33; general counsel when he was less than 36; vice-president, a director and a member of the executive committee when he was only 39, and in 1918 succeeded Lord Shaughnessy as president when he was barely 41 years old. He has been called on to measure up to the standards set by two of the real giants among the railway managers of North America—Sir William C. Van Horn and Lord Shaughnessy—and to guide the Canadian Pacific and its steamship lines through the very difficult and troubled period that has followed the great war. That he has measured up to those standards nobody who is familiar with the way this huge transportation system has been managed during this period will question, and after having been president of the Canadian Pacific for almost eight years he has barely reached what is ordinarily regarded as the prime of life. Those who will attend the dinner tonight will be peculiarly fortunate in having the opportunity to hear Mr. Beatty discuss railway questions which are of vital importance to the people of both Canada and the United States.

Is a Four-Day Session Convention Coming?

FOR the last two or three years it has been evident that some means must soon be taken to relieve the pressure on the A. R. E. A. program. The number of committees has been increasing and the number of subjects reported on by the committees has been increasing still more rapidly. In an effort to cope with this situation the Board of Direction has urged the committees to present their reports in abstract, and considerable progress has been made in this direction, although still further improvement is possible on the part of some committees.

The most serious feature of this situation is the fact that it is leading to the curtailment of discussion, the extent of which is shown by the fact that less than 50 of the nearly 800 members in attendance at the convention last year participated in the discussion. This is due in large measure to the fact that the members know of the pressure under which the association is working, and hesitate to take the time of the convention to present their experiences or views. This tendency toward curtailment of discussion is serious, for much of the discussion is as valuable as the report.

In an effort to provide time for more thorough discussion of the reports, a number of suggestions have been made among which are the reduction in the number of subjects which the committees are to be permitted to report on; the re-arrangement of the program so that the committees will report in alternate years and the extension of the convention for an additional day.

The A. R. E. A. has grown rapidly in membership in recent years. One of the principal values of membership is the opportunity to work on committees and to participate in the collection and analysis of information. As the membership has grown the number of men desiring to work on committees has increased correspondingly. With a larger number of men working on committees it is to be expected that they will do more work and complete more reports. Since this work is voluntary and performed without expense to the association it seems only proper that the association should organize to receive all reports and provide opportunity for adequate discussion. This indicates the desirability of extending the convention an additional day.

On first thought, some may oppose the extension because of additional time being required of them. This need not necessarily result. If the reports on related subjects, such as those on iron and steel structures, masonry and wooden bridges and trestles, be grouped on one day, instead of being distributed through the three days as this year, and if the reports of primary interest to track engineers be grouped on another day, the men who can conveniently spend only three days or, for that matter, only one or two days, can then select those days which will be of the maximum interest to them, while those who can afford the time and who are interested in all of the various subjects can and will arrange to stay for the fourth day. Such an extension of the program would afford an opportunity to stimulate discussion on the various reports, and add materially to the value of the proceedings.

The Committee on Economics of Railway Operation will meet in room 1502 at 12:30 this noon to consider the report that will be presented to the association tomorrow morning.

* * *

Among the visitors at the Coliseum yesterday were Y. Kimurei, assistant chief engineer, Japanese Government Railways, at Kobe, Japan, and Y. Yamanaka and K. Takata, assistant chief engineers, Japanese Government Railways, at Tokyo, Japan.

* * *

The friends of Morris Wuerpel, assistant to the president of the General Railway Signal Company, who noted his absence from the meeting of the Signal section yesterday, were sorry to learn that he is seriously ill at his home at Rochester, N. Y.

* * *

Contrary to the statement published in Tuesday morning's Daily, the Coliseum will remain open until 6:30 on Thursday evening to give those attending the meetings of the Signal section of the A. R. A. and of the A. R. E. A. an opportunity to visit the exhibit during the entire day.

* * *

Friends of F. W. Edmonds, who for 31 years has been one of the leaders in the signaling field and who was absent from last year's convention on account of severe continued illness, will be glad to know that he has now returned to his duties as secretary of the Signal Appliance Association, which position he has held since 1910, and was in charge of these activities during the convention at the Drake hotel last Monday and Tuesday. Mr. Edmonds has lately reorganized his business, known as the Craft, Incorporated, which has recently been appointed the sole licensees' and manufacturers of The Solry Tile Manufacturing Company products, a non-slip surface for stairways and ramps in railway and public buildings.

* * *

The Annual Dinner

Largely as a result of the enthusiasm created by the success of the last two annual dinners of the A. R. E. A., more than 850 reservations have been received for the dinner this evening. The arrangements for this year's dinner are in the hands of a new committee which promises that this year's dinner will be "different" from those of preceding years. The nature of the entertainment has not yet been announced although the speakers will include E. W. Beatty, president of the Canadian Pacific, who will speak on "The Engineer"; Dudley F. Holtman of the United States Department of Commerce, who will talk on "What Better Wood Utilization Means to the Railroads," and Rev. Alan P. Shatford, Canon of the Church of St. James the Apostle, Montreal, whose subject will be "Binding the Nations Together." The committee in charge of the arrangements this year includes J. R. W. Ambrose, (Toronto Terminals), chairman, J. B. Cox, W. A. Christian, C. R. Knowles (I. C.), G. P. Palmer (B. & O. C. T.), L. J. F. Hughes (C. R. I. & P.), A. C. Irwin (Portland Cement Association), J. deN. Macomb (A. T. & S. F.), J. E. Armstrong (C. P. R.), and E. H. Fritch (A. R. E. A.).

* * *

Inspection Trips

Several trips of inspection have been arranged by the Committee on Arrangements for Friday.

One of these trips includes an inspection of the steel mills of the Illinois Steel Company at Gary, Ind., and the plant of the Universal Portland Cement Company at Bufflngton, Ind. Buses will leave the Congress hotel at 8:15 a. m., and return to the hotel at 5 p. m. Provision will be made for the handling of baggage on the trip so that guests desiring to catch early trains can check out and take their baggage with them. This trip is provided through the courtesy of the Illinois Steel Company and the Universal Portland Cement Company.

The second trip involves the inspection of the frog and crossing plant of the Pettibone-Mulliken Company. Automobiles will leave the Congress hotel at 1:30 p. m. and return to the loop not later than 5 p. m. This trip is planned through the courtesy of the Pettibone-Mulliken Company.

The third trip includes the inspection of municipal work under way in Chicago, including the Wacker Drive, the Outer Boulevard drive, the Grant Park stadium, the Illinois Central viaduct at Twenty-third street and other ponts of interest. Buses will leave the Congress hotel at 9 a. m. and return to the hotel not later than 12:30 p. m. This trip is provided through the courtesy of the Chicago Plan Commission and the Portland Cement Association.

In order that adequate arrangements can be made for the accommodation of all who desire to make these trips, reservations should be made at the registration desk.

The A. R. E. A. Program

Today

Signals and Interlocking	**Bulletin 281**
Signs, Fences and Crossings	**Bulletin 282**
Yards and Terminals	**Bulletin 282**
Uniform General Contract Forms	**Bulletin 282**
Masonry	**Bulletin 282**
Stresses in Railroad Track	**Bulletin 282**
Rail	**Bulletin 283**
Track	**Bulletin 283**
Co-operative Relations with Universities	**Bulletin 285**

Annual Dinner, 6:30 p. m.

Thursday

Ties	Bulletin 283
Economics of Railway Operation	Bulletin 284
Roadway	Bulletin 284
Wooden Bridges and Trestles	Bulletin 284
Wood Preservation	Bulletin 284
Clearances—Progress Report	Bulletin 284
Economics of Railway Labor	Bulletin 285
Buildings	Bulletin 285

New Business.
Election and Installation of Officers.
Adjournment.

The Convention in Session on the First Day

Large Attendance at A. R. E. A. Meeting

The Florentine Room was packed at both morning and afternoon sessions—Eight reports were presented

THE Florentine room at the Congress hotel was crowded when President J. M. R. Fairbairn (chief engineer, Canadian Pacific System, called the twenty-seventh annual convention of the American Railway Engineering Association to order at 9:30 yesterday morning. The room was crowded throughout both the morning and afternoon sessions, while many members who found it impossible to secure seats remained in the corridors outside. Shortly after calling the convention to order Mr. Fairbairn reviewed the work of the association during the past year and commented on developments during the past 12 months. After receiving the reports of the secretary and treasurer the association then proceeded to the consideration of the reports of the standing and special committees, including those on Rules and Organization; Ballast; Iron and Steel Structures; Electricity; Economics of Railway Location; Water Service; Records and Accounts and Shops and Locomotive Terminals.

Address of President J. M. R. Fairbairn

OUR Association has, during the past year, continued the good work for which it was originally organized and progress is being made in every field of our labor. Our committees, as you will see from the reports already published, have done excellent work and, generally, the Association may be pleased with it's year's progress. The Treasurer's report will show that our financial position is both sound and gratifying.

I regret to say that during the year we have lost, by death, 21 of our members; among these, prominent in the work of the Association, were: Julius Kruttschnitt, A. M. Burt and W. M. Camp.

The Officers of the Association and the Members of the Board of Direction have, as usual, shown throughout the year's work an unfailing zeal and spirit of willing co-operation, for which I wish to express to them my most heartfelt appreciation and grateful thanks.

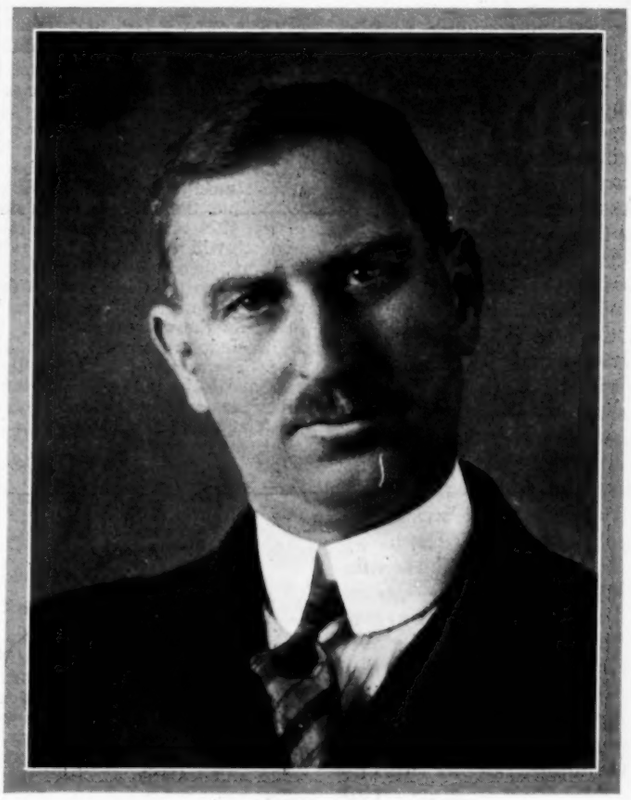
The report of the secretary will show that our membership has increased 3½ per cent during the year, this being our average for the past 7 years. From time to time this Association has conducted, through various mediums, spasmodic campaigns for additional membership, the results having been usually more or less gratifying, but when one looks over the list of members with their railway affiliations and geographical distribution and the annual increases in total membership, which vary in recent years all the way from less than 1 per cent to 16 per cent, one is at once struck by the desirability of a continuous campaign for new members in order that we may have, year by year, a more consistent increase in our numbers, which will, if possible, equalize in some degree the corporate and geographical distribution of the membership.

With this in view, the following outline of the work of the American Railway Engineering Association, its benefit to the railways, and to its own members, is given, in the hope that a clearer understanding of this work may increase the number of those connected with railway work who will interest themselves in this most valuable activity.

Our Association is now commencing its twenty-seventh annual convention, the principal business of which is the reception, consideration and approval, or otherwise, of the reports of the 23 standing commit-

tees and those special committees dealing with special assignments. To those of our members accustomed to attending the annual convention and those engaged in committee work the full meaning of this announcement is well known, but to those members not privileged to attend the convention or so situated that they cannot participate in committee work, as well as to the railway public outside our membership, this meaning is not, by any means, so clear. There is in the work of the Association, in its committees throughout the year, and at its annual convention, a very valuable asset, both to the railways, from whom our members are drawn, and to the members themselves, particularly those active in the work of our committees.

The membership of the standing committees of the association, varying in numerical strength from a minimum of 12 to a maximum of 34 members, is selected in each case by the Personnel Committee of the Board of Direction, with special reference to the qualifications of each individual for the particular work assigned to his committee. Again, the various subjects assigned to each committee are, of course, pertinent to the particular field which that committee covers and are selected carefully by the Outline of Work committee of the Board of Direction after the fullest co-operation with the committee chairmen in each case, with a view to covering, in any one year, only those subjects which are most urgently in need of analysis and solution by the railways.



J. M. R. Fairbairn
President

Mr. Fairbairn is a fitting representative, not only of the American Railway Engineering Association as a body, but also of the large number of Canadians who form an important part of that organization. He has always taken an active interest in the affairs of the Association and has given valuable service on the important Committees on Track, Rail, Standardization and Co-operative Relations with Universities. As chief engineer of the Canadian Pacific Railway, Mr. Fairbairn is in charge of the engineering work on that large system, with which most of his professional career has been identified.

A study of the committee reports during the life of the Association is a liberal education in the field of railway location, construction and maintenance, as well as giving much enlightenment on many features of operation. To follow the work of the association through its annual proceedings gives one a most comprehensive idea of the improvement in the art of manufacturing transportation, and at the same time shows clearly what has been done to simplify practice and to standardize materials and structures, all of which tends to the maximum of efficiency in the personnel, and economy to the companies.

The 26 volumes, of which the annual proceedings consist, and the Manual, giving the recommended practice of the Association, constitute a reference library which no railway officer can well afford to be without. The recommended practice of the Association on any particular subject is clearly set forth in the Manual, and the considerations leading up to such recommended practice may be found in the committee reports, while the discussion by the membership at large on the same subject, as called forth at the Annual Meeting, is readily available in the Proceedings as published.

With this information at hand, any railway officer, even though not a member of the Association, can get a very fair idea of the best American practice and the reasons therefor, but to get the greatest value from the work of the association it is necessary that one should be a member, busy working on one or more committees, or subcommittees, attending the meetings of these and participating in the committee discussions, where all the details of any subject are thoroughly thrashed out.

To the committee member the opportunity is afforded of intensive study of interesting problems which arise in his daily work, but instead of struggling alone with these problems he has the great advantage of conferring with a group of others, equally interested with himself in the same problem, having varied experience on other railways affected by different conditions of organization, traffic, physical formations, and climate.

This study, coupled with the opportunity to meet and get to know personally a large number of others in the same line of effort, is a distinct advantage to any man, broadening tremendously his point of view and, consequently, enhancing his value to the company which he serves. Many committees, by so locating their meetings that their members can see and study various structures, layouts or methods, have given their members opportunities for such study seldom obtained by the individual officer.

The work already done has assisted materially in the simplification of much of the work of railway officers, but there is still a tremendous field to cover. New conditions arising annually bring new assignments from the Outline of Work committee to the various standing committees. Many subjects run for years before adequate collection of data, investigation and study enable a committee to reach a definite con-

clusion, and even then the Convention sometimes overturns such definite conclusion and it becomes necessary that the whole subject be considered again.

It is to be earnestly hoped that as the work of this association becomes more intimately known to railway executives, they will take a keener interest in it and will give more widespread encouragement to junior officers to join the Association, grow up with it, and take part in its committee activities.

This service is, of course, a voluntary one, similar to the service given by a number of sister associations of like aims and kindred activities, but such a service has a most beneficial reaction on each individual concerned and may well engender in him the satisfaction born of a consciousness that these associations have in no small degree contributed to the building up of that fabric of railway knowledge upon which all great land transportation systems are based.

I am informed that our Association's specifications and recommendations in the field of railway practice are studied throughout the English speaking nations and by many others interested in the science of transportation, not only in the old continent of Europe but in the newly awakened Orient. This calls forth the hope that more of our co-workers in the railway field in these foreign countries will be induced to become members of this association, and thus join in carrying on this International work of broadcasting the principles of good practice in railway matters. It is only necessary to peruse the technical press of the world on railway construction, track work, terminal, locomotive and bridge design in order to appreciate the extent to which our practice has influenced that of foreign countries.

Gentlemen, the great calling in which we are all engaged is, I submit, a noble one, affecting the welfare of the whole world, and I am confident that time will show that not only are we assisting to annihilate distance and bring the nations closer together, but we are also directly helping to create similarity of national ideals and a better understanding of one another among the nations of the earth.

Report of the Secretary

The activities of the respective committees in the past year have been directed in the following proportions:

On roadway and track problems	28 per cent
On structure problems	22 per cent
On railway economics	10 per cent
On operating problems	15 per cent
On railway labor problems	6 per cent
On miscellaneous engineering problems	19 per cent
	100 per cent

Membership

The following table shows the changes in the membership during the fiscal year:

Membership as of March 1, 1925			2227
Additions during the year	183		
Losses by death	21		
Resignations	43		
Dropped from rolls	42	106	
Net gain		77	77
Total membership as of March 1, 1926..			2304

Deceased Members

Edmund H. Bowser, superintendent tie and timber department, Illinois Central.
L. R. Brine, first assistant engineer, Atlanta, Birmingham & Atlantic.
Hardy Bryan, assistant engineer, Northern Pacific.
Aaron Moulton Burt (*Director*), vice-president—Operation, Northern Pacific.
Walter Mason Camp, editor, *Railway Review*.
J. K. Conner, chief engineer, New York, Chicago & St. Louis.
Arthur Crable, engineer maintenance of way, Hocking Valley.
C. R. Fickes, resident engineer, Florida East Coast.
T. H. Gatlin, chief engineer construction, Southern.
John S. Goodell, civil engineer.
C. E. Gosline, track engineer, Delaware, Lackawanna & Western.
John W. Harshaw, division engineer, Southern Pacific.
Julius Kruttschnitt, chairman executive committee, Southern Pacific.
H. A. Lloyd, maintenance inspector, Erie.
W. L. Mapother, president, Louisville & Nashville.
Bertram Clifford Martin, resident engineer, Hudson River Connecting Railroad (New York Central Lines).
Charles Henry Miller, president, Miller-Butterworth Company.
John R. Onderdonk, engineer of tests, Baltimore & Ohio.
G. E. Potter, division engineer, New York, Chicago & St. Louis.
J. W. Sammons, assistant engineer, International-Great Northern.
Miles Cary Selden, superintendent, Chesapeake & Ohio.

Publications

The additions to and changes in the last edition of the Manual (1921) make it desirable to reissue the volume in the near future. Several committees have made extensive revisions in their current reports; other committees are contemplating similar revisions in their respective sections. The Board of Directors has therefore decided upon a complete reissue of the Manual following the annual meeting of 1927, to include all matter adopted since the 1921 issue, the changes made since that time, and also the action of the 1926 and 1927 annual meetings. The next edition of the Manual will consist of approximately two thousand pages. In addition, there will be a portfolio of plans for track work, etc.

The Board of Direction has decided upon a reissue of the General Index of the Proceedings, bringing the volume up to date, including the current number. The first issue appeared in 1915, and included references to the contents of Volumes 1 to 16, inclusive. The work of compiling the additions is under way and it is expected to issue the revision during the current year. The General Index will be of material assistance in readily referring to the great amount of valuable data included in the twenty-seven volumes of Proceedings.

Finances

The following is a condensed summary of the Financial Statement given in Exhibit A.

Receipts during the year	$50,927.97
Disbursements	49,744.31
Excess of Receipts over Disbursements	$ 1,183.66

Conclusions

(1) The American Railway Engineering Association is the realization of an ideal, carefully worked out and persistently followed for more than a quarter of a century.

(2) The Association has been of practical benefit to the transportation industry by progress made in uniformity of practice and standardization—in terminology, methods and structures.

(3) It has advanced and extended railway engineering knowledge, and fostered a spirit of co-operation and fellowship among engineers.

(4) The elements which have contributed to its successful working are briefly: (a) A definite program; (b) Continuity of purpose; (c) Co-operation and loyalty of the members; (d) Thorough and conscientious committee-work; and (e) Encouragement from railway managements.

(5) Railway operations are becoming constantly more complex, and the problems involved call for analytical ability of the highest order. The members of the American Railway Engineering Association are especially well-qualified to aid in their proper solution, and it is safe to assume that the same spirit of enthusiasm and unselfish devotion will characterize its future activities as it has in the past.

Financial Statement for Calendar Year Ending December 31, 1925

Balance on hand January 1, 1925 ..... $54,431.06

RECEIPTS

Membership Account		
Entrance Fees	$ 1,740.00	
Dues	22,913.25	
Binding Proceedings and Manual	1,678.93	
Badges	14.00	
Sale of Publications		
Proceedings	3,771.72	
Bulletins	1,489.35	
Manual	1,287.40	
Specifications	490.65	
Leaflets	178.75	
Advertising		
Publications	2,357.10	
Interest Account		
Investments	2,704.65	
Bank Balance	226.91	
Annual Meeting		
Sale of Dinner Tickets	3,695.00	
Miscellaneous	289.96	
American Railway Association		
Rail Investigations	8,090.32	
Total		$50,927.97

DISBURSEMENTS

Salaries	$10,369.88
Proceedings	5,098.77
Bulletins	11,462.78
Manual	56.25
General Index	1,250.00
Stationery and Printing	1,654.49
Rents, Light, etc.	845.00
Supplies	732.61
Expressage	608.58
Postage	1,271.54
Exchange	72.20
Committee Expenses	25.95
Officers' Expenses	111.35
Annual Meeting	6,772.81
Refund Dues, etc.	14.00
Audit	150.00
Miscellaneous	901.30
American Railway Assn.—Rail Investigations	8,346.80
Total	$49,744.51

Excess of Receipts over Disbursements	$ 1,183.66
Balance on hand December 31, 1925	55,614.72
Consisting of:	
Bonds at Cost	$45,785.89
Cash in S. T. & S. Bank	9,803.83
Petty Cash Fund	25.00
	$55,614.72

STRESSES IN TRACK FUND

Balance on hand January 1, 1925	$ 3,057.06
Received from interest during 1925	85.81
Total	$ 3,142.87
Paid out on Audited Vouchers during 1925	1,033.21
Balance of fund on hand December 31, 1925	$ 2,109.66

Report on Iron and Steel Structures

The Committee on Iron and Steel Structures submitted a code of instructions for the maintenance inspection of superstructures of steel railway bridges which it recommended be accepted for publication in the Manual in place of the material under that subject now in the Manual. It submitted as information specifications for the waterproofing and draining of solid floor bridges by the use of membrane system water proofing. The committee has collected information on the use of copper-bearing steel which it has found to last twice as long as ordinary steel for steel cars, tie plates, track spikes and stationary boilers and suggests that investigation should be made as to its suitability for bridges. O. F. Dalstrom has been chairman of the committee for four years and a member for five years.

O. F. Dalstrom
Chairman

THE committee presented reports covering the following subjects: 1, Revision of Manual (Appendix A); 2, Specifications for steel highway bridges —Progress—(Appendix B); 6, Instruction for maintenance inspection of superstructures of steel bridges (Appendix C); 9, Column tests (Appendix D); 10, Specifications for the waterproofing and drainage of solid-floor railway bridges (Appendix E); 11, Investigation of copper-bearing steel for structural purposes (Appendix F).

It recommended: 1. That the report on the revision of the Manual (Appendix A) be acted on as follows: The part covering bearing pressures on large rollers and the part covering "punched work" and "reamed work" be received as information, and the part covering removal of certain portions of the Manual be approved; 2. That the report on specifications for steel highway bridges (Appendix B) be received as information; 6. That the report on instructions for maintenance inspection of superstructures of steel bridges (Appendix C) be approved for publication in the Manual; 9. That the report on column tests (Appendix D) be received as information; 10. That the specifications for the waterproofing and drainage of solid-floor railway bridges (Appendix E) be received as information; 11. That the report on the investigation of copper-bearing steel for structural purposes (Appendix F) be received as information.

Committee: O. F. Dalstrom, Chairman (C. & N. W.); B. R. Leffler, Vice-Chairman, (N. Y. C.); P. S. Baker (Reading), J. E. Bernhardt (C.& E. I.), A. W. Carpenter (N. Y. C.), M. F. Clements (N. P.), R. P. Davis (Univ. of W. Va.), F. O. Dufour (Lafayette Coll.), Thos. Earl (Bethlehem Steel Co.), W. R. Edwards (B. & O.), G. A. Haggander (C. B. & Q.), Reuben Hayes (Sou.), C. S. Heritage (K. C. S.), Otis E. Hovey (Am. Bridge Co.), J. B. Hunley (C. C. C. & St. L.), G. H. Gilbert (Sou.), P. G. Lang, Jr. (B. & O.), Crosby Miller (C. & O.), P. B. Motley (C. P. R.), Albert Reichmann (Am. Bridge Co.), A. F. Robinson (A. T. & S. F.), H. N. Rodenbaugh (F. E. C.), O. E. Selby (C. C. C. & St. L.), I. L. Simmons (C. R. I. & P.), P. B. Spencer (N. Y. N. H. & H.), R. O. Stewart (C. N. R.), H. B. Stuart (C. N. R.), R. M. Stubbs (M.-K.-T.), G. H. Trout (U. P.), F. E. Turneaure (Univ. of Wis.), F. P. Turner (N. & W.), H. T. Welty (N. Y. C.), A. R. Wilson (Penna.), W. L. Wilson (Lehigh Univ.), W. M. Wilson (Univ. of Ill.)

Appendix A—Revision of Manual

During the past year the third edition of the General Specifications for Steel Railway Bridges was issued. This edition includes all revisions adopted by the Association to August, 1925. These specifications should replace the specifications in the 1921 edition of the Manual. The matter under the subject, Inspection of Bridges and Records of Inspection, page 725 of the 1921 edition of the Manual, should be eliminated as it will be superseded by the matter in Appendix C of this report.

Appendix C—Instructions for the Maintenance Inspection of Superstructures of Steel Railway Bridges

1. **Responsibility of Inspectors**—These instructions are for the guidance of inspectors in the maintenance inspection of steel railway bridges. Inspectors will be held responsible for the performance of their duties in accordance with these instructions.

2. The Inspector shall make a complete detailed inspection of every bridge.

3. **Communications**—Unless there are other instructions, copies of communications sent to other officials shall be sent to the bridge engineer.

4. **Drawings and Rules**—The Inspector shall be

familiar with standard bridge drawings, and the rules and instructions applying to the maintenance of bridges.

5. **Bridge List**—A list of bridges will be furnished to the inspector by the bridge engineer. This list will give the number (or name) and location of each bridge, type of superstructure, and lengths of spans. In each case the number (or name) and location of the bridge given in the list shall appear on the Inspector's report. The inspector shall report any errors in the information given in the list, and shall furnish other information to the bridge engineer when required.

6. **Emergency Reports**—If a bridge is found in need of immediate repairs for safety, the inspector shall notify, by the quickest means available, the proper division official and the bridge engineer, giving the bridge number (or name), description, location, nature of defects, and temporary repairs needed. The Inspector shall send to the above mentioned officials, by the first train, a complete report in writing, with a detailed sketch showing the defects. If necessary, the Inspector shall protect traffic in accordance with the rules of the operating department.

7. **Reports**—The Inspector shall make a record of the inspection of every bridge. This record shall be made at the site, at the time of the inspection, and on a form provided for that purpose. He shall make a written report as required, giving his recommendations as to the repairs needed and when they should be made.

8. On the report form which accompanies these instructions, are listed the features most frequently found in need of attention, but this form shall not be taken as listing all features requiring inspection. Remarks on features not listed in the form shall appear on the blank part of the form or on a separate sheet. Only one side of a sheet shall be used.

9. On the report form symbols shall be used as follows:

O—Opposite items which do not apply to the bridge inspected.

OK—Opposite items referring to features which do not need attention.

X—Opposite items under which are made special remarks on repairs needed. The identifying numbers of the items so marked shall be entered in the blank ruled part of the sheet, with a concise but complete description of the features needing attention, together with recommendations for repairs.

One of these symbols shall appear opposite every item on the form.

10. **Features to Be Examined**—(The committee then presented a very detailed list of the features an Inspector should examine in going over a bridge. Because of their length, these details are omitted here.—Editor.)

11. **General**—The inspector shall report indications of overload or failure in any part of the bridge. He shall observe the behavior of the bridge during the passing of live load, if practicable, noting excessive vibration, deflection, and side sway.

Attachments of wires, pipes, etc., that may be harmful to the bridge shall be reported.

Appendix E—Specifications for the Waterproofing and Drainage of Solid-Floor Railway Bridges

Complete specifications were given for the waterproofing and drainage of solid-floor bridges, with the statement that, "these specifications apply to membrane waterproofing, which is the only kind recommended for solid-floor railway bridges. The waterproofing shall consist of a membrane covered by a protection course of brick, concrete or asphalt mastic." The specifications were presented as information.

Appendix F—Copper-Bearing Steel for Structural Purposes

The sub-committee has collected information on the use of copper-bearing steel and finds that it is being used in the manufacture of steel cars, tie-plates, track spikes, smoke stacks, and stationary boilers. Copper-bearing steel in such service has been found to last twice as long as ordinary steel. It has been little used in bridge construction, and further investigation should be made to determine if it is suitable for that purpose.

Supplemental Report

The committee submitted a supplemental report on the work that it had done on Subject No. 4, rules for lighting bridges, and a uniform code of regulations and signals for operating draw bridges. This subject has been on the committee's outline of work about five years, during which time it was studied carefully by a special sub-committee. The committee submitted its findings on the subject in the following three conclusions: 1. That the lack of uniformity in the rules for operating draw bridges does not affect the railways disadvantageously. 2. That the matter of lighting and operating draw bridges has been, to a very large extent, local in its application, and no material benefit would be derived from standardization. 3. That the full development of the subject might lead to the consideration of questions seriously affecting the cost of operation of railways.

The committee recommended that this subject be withdrawn from its outline of work.

Discussion

[The report was presented by Chairman B. F. Leffler. Under Revision of Manual, the parts referring to bearing pressures and large rollers, and the part covering "punched work" and "reamed work" were accepted as information while the part covering the removal of certain portions of the Manual was deferred at the request of the committee. The report on Appendix B was received as information.]

The report on Instructions for Maintenance Inspection of Superstructure of Steel Bridges was then presented.

W. C. Barrett (L. V.): During the past year, the committee on Rules and Organization has been working in very close cooperation with this committee in the revision of the rules now appearing in the Manual for inspection of bridges, trestles and culverts, whether steel, wood or iron. It had a report practically completed, but was asked to defer that until this Committee on Iron and Steel Structures had revised their rules.

These rules are that revision, but inasmuch as the Committee on Rules and Organization had no opportunity to cooperate with or collaborate with this committee, I want to raise the question as to whether or not it is proper to put rules for inspection of steel structures in the Manual when we already have rules for the inspection of all sorts of bridges.

H. B. Stuart (C. N. R.): I think the two committees should get together and agree on these rules.

Chairman Leiffler: Do I understand that it is the wish of the Chairman of the Committee on Rules and Organization that these instructions be not put

into the Manual until they have been passed upon by the Committee on Rules and Organization?

Mr. Barrett: That is the thought I had, not because we wanted to take from the committee any of its authority, but because otherwise there will be duplication.

Chairman Leffler: Is it the intention to change the substance of these rules or just the location in the Manual?

Mr. Barrett: Our report included the rules that this committee has already printed in the Bulletin for information, and it would be our intention, if this matter were deferred for another year, to work as we did during this past year very closely in cooperation with this committee to have one set of rules by both committees. *I move that the instructions for inspection of steel structures be referred back to the committee for collaboration with the Committee on Rules and Organization during the ensuing year.*

The motion was carried.

Appendices D. E. and F. were accepted as information.

The recommendations in the supplementary report on Rules for Lighting Bridges were adopted, after which the committee was dismissed with the thanks of the Association.

Report on Economics of Railway Location

The Committee on Economics of Railway Location, conferring with the Committee on Electricity, presented a progress report in which the effect of the introduction of electric locomotives on the economics of railway location was considered. The sub-committee which prepared this report was not unanimous in its opinions and a minority report was also presented. A progress report was presented on the relative merits of an 0.4 per cent ruling grade as compared with an 0.3 per cent ruling grade. The committee expects that additional information on this subject will be obtained which will enable it to devote further study to the subject and to formulate a more comprehensive report at some future time. E. E. King has been chairman for 3 years and has been a member of the committee for 4 years.

E. E. King
Chairman

THE committee presented reports covering the following subjects: 1, The economics of railway location as affected by the introduction of electric locomotives, conferring with the Committee on Electricity (Appendix A). 2, The relative merits of a 0.4 per cent ruling grade as compared with a 0.3 per cent grade (Appendix B).

The committee recommended: 1, That the material in Appendix A, including the conclusions, be accepted as a progress report. 2, That the material in Appendix B be accepted as a progress report.

A monograph on the Effect of Minor Sags and Humps, by Walter Loring Webb, was appended to the report.

Committee: E. E. King (U. of Ill.), Chairman; H. C. Searls (M. P.), Vice Chairman; F. L. Batchelder (C. R.), John C. Beye (I. C. C.), A. S. Cutler (U. of Minn.), A. S. Going (C. N. R.), C. P. Howard (I. C. C.), Frank Lee (C. P. R.), Fred Lavis (Con. Engr.), F. R. Laying (B. L. E.), C. L. Persons (C. B. & Q.), I. L. Pyle (C. & O.), E. C. Schmidt (U. of Ill.), A. K. Shurtleff (A. R. E. A.), C. W. Stark (U. S. Ch. of Com.), P. E. Thain (N. P.), R. H. Washburn (C. & A.), Walter Loring Webb (Cons. Engr.), A. H. Woollen (I. C.), F. E. Wynne, (Westinghouse El. Co.), M. A. Zook (M. W. & S.).

Appendix A—The Economics of Railway Location as Affected by the Introduction of Electric Locomotives, Conferring with the Committee on Electricity

The location of a new railway line would be definitely affected by the introduction of electricity as motive power, irrespective of where the power would be derived, so that a discussion of the kind of electric system is not pertinent to this subject.

1. Alinement and Profile.—The principal economy to be effected by the introduction of the electric locomotive as a form of motive power for a projected railway line lies in the modification of the ruling grade, it being possible to follow more closely the natural topography of the country. Unless the country were level in character, less linear curvature would be possible, shortening the total mileage of the system accordingly. In mountainous country and in crossing rivers or other waterways, tunnel construction of any length (as far as operating conditions are concerned) can be employed.

2. Characteristics of Electric Locomotives.—The maximum tractive effort which may be exerted by an electric locomotive is dependent upon the weight on drivers and may be maintained from zero speed up to some speed determined by the motor characteristics. The tractive effort is uniform at any given speed, decreasing as the speed increases, and always has a definite relation to speed, depending on the characteristics of the motors used. A steam locomotive, on the other hand, is limited by grate area and boiler capacity and its tractive effort is governed by the mean effective pressure that can be maintained in the cylinders. Because of the reciprocating motion of the steam locomotive and the necessity for absorbing the reciprocating forces, there is not a uniform torque on the wheels; but the real limiting feature is the boiler, as it is only fair to assume that running gear could be designed adequately to produce the equivalent of the uniform torque of the electric locomotive. Electric locomotives of the side-rod type introduce some of the reciprocating motions of the steam locomotive; but while affecting the efficiency of transmission to some

degree, these do not affect the uniform turning moment of the motors.

The advantage gained by the electric locomotive is in the ability to put the desired power into a practical locomotive frame and maintain that power independent of such limitations as boiler size, grate area, stokers, fuel and water. In other words, we may consider the boiler and combustion equipment of a locomotive as moved to a stationery power plant where it is not limited and can grow as the demand increases.

Electric locomotives operated on the multiple unit principle can be designed as a unit and as many units employed as necessary within the limits of draft-gear design to move a given tonnage over the line, with but one crew.

3. **Availability of Motive Power.**—It has been demonstrated by the electrified railroads of this country that electric locomotives can be operated at greater distances from repair shops and for longer periods between shoppings for inspection or overhaul than steam locomotives, due to the lesser necessity for and the greater ease of making renewals to electric locomotives.

This feature of the electric locomotive should affect the economics of railway location, in that terminal facilities for turning of locomotives, inspection and repairs could be located at the most economic points, and raw supplies and labor obtained more readily and cheaply.

4. The foregoing discussion applies to electric locomotives that take energy from an external source, such as a contact wire or rail. The committee wishes to draw attention to the consideration being given at the present time toward the internal combustion engine as a form of prime mover for locomotives, which in combination with electric drive, makes an independent unit with some of the desirable characteristics of the electric locomotive and without the attendant disadvantages of transmission, distribution and conversion equipment. In addition, a thermal efficiency from fuel to rail of some 25 to 30 per cent is indicated, as against 12 per cent for the electric locomotive and power system, and 5 to 6 per cent for a steam locomotive. The introduction of this type of electric locomotive will affect railway location, as these locomotives can carry sufficient fuel and other supplies for six to seven days' run. It is yet to be shown whether the internal combustion engine electric locomotive will also have the advantages stated in paragraph 3.

Conclusions

1. The introduction of the electric locomotives may affect the economics of railway location with respect to:
   (a) The ruling grade,
   (b) Total curvature,
   (c) Length of tunnels,
   (d) Location of repair, inspection and terminal facilities.
2. Each proposed railway must be studied and a separate determination made as to whether electrification is economically justified.
3. This subject should be continued and data collected which could be used for the economic study referred to in Conclusion 2.
4. The performance of self-contained power plant locomotives should be followed as affecting further reports on this subject.

Minority Report

The undersigned member of sub-committee No. 2 does not agree with the form or matter of the report presented. He believes that the effect of electric traction on the economics of railway location can only be set forth in a report of this kind in the most general terms. The details of the subject should be either much more voluminous or be omitted entirely.

The details and ramifications of this subject are so many and varied that, in the writer's estimation, they could not be covered properly except in an extensive treatise, and even then could only be applied to a specific case by a group of civil, electrical and mechanical engineers and operating men having extensive, intimate knowledge of the subject.

The undersigned also objects to the conclusions of sub-committee, No. 1 of which states that the introduction of electric locomotives may affect the economics of railway location with respect to: (a) The ruling grade, (b) Total curvature, (c) Length of tunnels, and (d) Location of repair, inspection and terminal facilities. While this is true, it is also true that they may not, and this can hardly be called a conclusion. Conclusion 2 is also a truism, which applies to almost anything. In regard to Conclusions 3 and 4, it is the opinion of the writer that it is unwise to set forth as conclusions, or to include in the Manual, anything but the broadest general principles in regard to this subject.

F. Lavis.

Discussion

[The afternoon session was called to order by First Vice-President C. F. W. Felt, who called the Committee on Economics of Railway Location. The report was presented by Chairman E. E. King and that part treating of the economics of railway location was accepted as information after which the report on the relative merits of a 0.4 per cent ruling grade as compared with a 0.3 per cent grade was presented, with the motion that it be accepted as information.]

J. B. Jenkins (B. & O.): This committee could very well go further and show the relation between the tonnage, the amount of money that could be expended, and the advantage that would accrue from the expenditure of that money. There is a necessary relation between the three and I think the committee should cover that point.

F. R. Layng (B. & L. E.): The committee is in correspondence with a number of other roads that are using these lighter grade lines and we are collecting that data.

R. H. Ford (C., R. I. & P.): I am glad the committee is developing along the lines that the report indicates. There isn't any doubt that a revision of the grades is going to revolutionize railway practice in this country. Nor is there any doubt that the question of rates and the questions of competition by the automobile truck and by waterways are going to be very much affected by the work that the railroads are just coming into on this question of grade reduction.

I am glad the committee has referred to the grade lighter than four-tenths. The general feeling of those roads who have adopted the four-tenths grade line on their main lines is that the question of sixty or seventy or even one hundred foot fills or cuts has little significance compared to the question of the efficiency of their railroad.

The outline that the committee has prepared here today opens a new avenue for much of the work that this Association will do in the future. The problem of railway rates and the efficient and economic operation of a railway is centered very largely around the work that this committee will do in the future, and I want to bespeak for the committee the earnest and helpful assistance of this Association.

J. L. Campbell (S. P.): I had not intended to discuss

this report of the committee at this time. I wouldn't want to undertake it unless I had made special preparation, which I have not done, but in this connection I do want to read into the records a correction in connection with a subject that comes directly within the work of this committee. It is in Bulletin 285; beginning on page 1221 there is a monograph on the effect of the physical characteristics of a railway line. If any of the members have Bulletin 285 with them now, they can take their pencils and make these corrections. It may save you a little confusion if you get around to reading this monograph. (Mr. Campbell then read the corrections referred to.)

J. M. Metcalf (M.-K.-T.): There is one other factor in this problem that has not been touched on in this report which I would suggest should be treated in this connection, and that is the character of traffic in the possible train length limit, which will affect the economy of the lighter grade.

Maurice Coburn (Penna.): This is a very important report and we hope the committee can carry it further and give us more exact data as to a good many of the points that are mentioned. There have been a good many grade changes made on a good many railroads where they have made the mistake of not remembering that the increased trainload is going to slow up the movement.

Vice-President Felt: Is there any further discussion? If not, this will be considered as accepted and the committee will be dismissed with the thanks of the Association.

Report of Committee on Electricity

The Committee on Electricity presented as information an interesting study on the utilization of water power for electric railway operation, in which figures were given showing the developed water power in the United States by geographical sections, and the potential water power resources for the same sections. Specifications were submitted for approval as recommended practice and inclusion in the manual covering the maintenance of overhead electric supply lines; joint use of poles for power; communication and signal circuits; porcelain insulators; and friction tape. It also presented for adoption a revised schedule for tungsten lamp standards. E. B. Katte has been chairman of the committee for 10 years and a member for the last 15 years.

E. B. Katte
Chairman

THE committee presented reports covering the following subjects: (1) Revision of the Manual (Appendix A); (2) Study of electrical interference caused by propulsion circuits, including recommendations for eliminating interference with signal, telephone and telegraph lines caused by propulsion circuits and adjacent transmission lines (Appendix B); (3) Study and report on the utilization of water power for electric railway operation (Appendix C); (4) Collaboration with the American Committee on Electrolysis (Appendix D); (5) Collaboration with the United States Bureau of Standards in the revision of the National Electrical Safety Code and other codes of similar character. Study of electric light, power supply and trolley lines crossing railways, with the view of keeping the association informed with regard to changes which may be desirable in the adopted specifications to make them conform more nearly to the requirements of Part II of the National Electrical Safety Code, prepared by the United States Bureau of Standards, and with the requirements of public service commissions and other regulatory bodies in the various states (Appendix E); (6) Study and report on the specifications for the construction of overhead electric supply lines for railway use on railroad property, collaborating with the appropriate committee of the signal section and the telephone and telegraph section. (Appendix F); (7) Study and report on economics of railway location as affected by electric operation, collaborating with committee on economics of railway location (Appendix G); (8) Study and report on the specifications for adhesive and rubber tapes (Appendix H); (9) Study and report on specifications for porcelain insulators for railroad supply lines, collaborating with the appropriate committees of the Signal section and the Telephone and Telegraph section, with the view of advancing the tentative specifications to recommended practice (Appendix I); (10) Revision of the tables showing third rail clearances and tables showing overhead working conductor clearances contained in last year's report (Appendix J); (11) Study and report on rules for the protection of oil sidings from danger due to stray currents, with the view of keeping the adopted rules revised and up to date, co-operating with appropriate committees of other interested associations (Appendix K); (12) Study and report on specifications for track and third rail bonds for electric railway circuits, including gas, electric and thermit welding (Appendix L); and (13) Revision and bringing up to date of the adopted specifications for incandescent lamps and schedule of sizes (Appendix M).

It recommended that the following be approved as recommended practice, and printed in the Manual: Specifications for maintenance of overhead electric supply lines (Appendix F); specifications for the joint use of poles for power, communication and signal circuits (Appendix F); specifications for friction tape (Appendix H); specifications for porcelain insulators for railroad supply lines (Appendix I); accept as information and print in the Manual, Clearance Tables for Third Rail and Overhead Working Conductors (Appendix J); approve as recommended practice and

substitute for the existing schedule in the Manual, incandescent lamp schedule (Appendix M); and that the other reports be accepted as information.

Committee: E. B. Katte (N. Y. C.), Chairman; W. M. Vandersluis (I. C.), Vice-Chairman; F. Auryansen (L. I.), H. M. Bassett (N. Y. C.), D. J. Brumley (I. C.), R. D. Coombs (Con. Engr.), J. C. Davidson (N. & W.), J. H. Davis (B. & O.), J. V. B. Duer (Penna.), G. Eisenhauer (Erie), F. D. Hall (B. & M.), L. B. Martin (I. T. S.), R. J. Middleton (C. M. & St. P.), W. L. Morse (N. Y. C.), R. J. Needham (C. N. R.), A. E. Owen (C. of N. J.), Martin Schreiber (P. S. Ry.), E. B. Temple (Penna.), H. M. Warren (D. L. & W.), L. S. Wells (L. I.), S. Withington, (N. Y. N. H. & H.), G. I. Wright (I. C.).

Appendix A—Revision of Manual

The committee recommended that the association approve as recommended practice and print in the Manual: (a) specifications for Maintenance of Overhead Electric Supply Lines (Appendix F); (b) specifications for Joint Use of Poles for Power Communication and Signal Circuits (Appendix F); (c) specifications for Friction Tape (Appendix H) to supersede the specifications for Adhesive Tape now in the Manual; (d) specifications for Porcelain Insulators for Railroad Supply Lines (Appendix I); (e) accept as information, and print in the Manual, Clearance Tables for Third-Rail and Overhead Working Conductors (Appendix J); (f) approve as recommended practice and substitute for existing schedule in the Manual the Tungsten Lamp Schedule—1925 (Appendix M).

Appendix B—Inductive Co-Ordination

The activities of the committee were confined to representation on the American Committee on Inductive Co-ordination, concerning which full information was given in last year's report. This committee has issued a questionnaire to the various constituent bodies, but up to the present time (November 1) the results thereof have not been issued. The railroad interests have submitted the reply to the questionnaire through Secretary H. J. Forster, of the American Railway Association.

It was recommended that the subject be continued and the activities of the committee for the present be confined to representation on and working with the American Committee on Inductive Co-ordination.

Appendix C—Water Power

The work of the sub-committee was in the nature of a review of the past work under this subject, bringing the data previously prepared up to date.

The sub-committee presented data showing developed water power as well as potential water power in the United States, listing each by sections of the country, and has made a study of the relation of present development to future possibility; a similar study was made for Canada.

Appendix D—Electrolysis

The sub-committee is at present engaged in an attempt to formulate grounding rules which will be acceptable to the various interests represented on the American Committee on Elctrolysis, with which the sub-committe is co-operating. It was recommended that representation on the American Committee on Electrolysis be continued without commitment as to subscription or dues until a definite program is submitted to the board of direction for its action.

Appendix E—Co-Operation With the U. S. Bureau of Standards

The committee has conferred with the U. S. Bureau of Standards in the revision of various parts of the National Electric Safety Code. It outlined the present status of the work stating that several sections are nearly completed and recommended that co-operation with the Bureau of Standards be continued.

Appendix F—Overhead Transmission Line Construction

The sub-committee submitted specifications for the maintenance of overhead electric supply lines, with an addendum containing specifications for the joint use of poles for power, communication and signal circuits, this addendum being as follows:

1. Scope. This addendum describes the standard practice for the joint use of electric power, transmission, and distribution circuits, as defined below, with signal and communication circuits on wood pole lines for railroad use, on railroad property. These provisions do not apply to pole lines where Class "S" and "T" circuits only are involved.

These provisions are to be used in connection with the foregoing specifications, all the requirements of which, except as modified by this addendum, are to be followed.

Where Class "P-1" and "P-2" circuits are concerned with communication circuits, joint construction is not recommended but may be used where the right-of-way is restricted and the construction of separate pole lines would result in close clearance to tracks, buildings, etc., and between lines unless the character of the circuits makes joint use undesirable.

2. Classification of Circuits. The circuits involved are classified as follows:

(a) Power Transmission and Distribution Circuits.

P-1 Constant potential alternating current circuits not exceeding 750 volts between conductors, 440 volts to neutral or ground, and direct current circuits not exceeding 750 volts to ground.

P-2 Constant potential alternating current circuits of voltages between 750 and 5000 volts between conductors (or voltage between 440 and 2900 to neutral or ground) and constant current circuits of not more than 7.5 amperes.

S Constant potential circuits, alternating current or direct current, not exceeding 550 volts between conductors or 320 volts between neutral or ground and the transmitted power of which does not exceed 1600 watts.

(b) Communication and Signal Circuits.

T Communication or signal circuits which operate at not exceeding 440 volts to ground or 750 volts between any two points of the circuits or the transmitted power of which does not exceed 150 watts, below 150 volts no limit is placed on the capacity of the system.

3. Relative Position of Different Classes. The relative position on a pole of the line conductors of different classes, when present, shall in general be from the top of the pole downward, as follows: Class P-2, Class P-1, Class S, Class T.

Where all circuits are owned or operated by one party or cooperative consideration determines that the circumstances warrant and the necessary coordinating methods are employed, double braid weatherproof covered wires carrying a voltage not to exceed, where practicable, 440 volts, or in exceptional cases, 550 volts between conductors with transmitted power not in excess of 1600 watts when involved in the joint use of poles with signal circuits, may be carried below the signal circuits under the following conditions:

(1) That such supply circuits are of wire having a good grade of commercial weatherproof covering not smaller than No. 8 A. W. G. medium hard drawn copper or its equivalent in strength and the construction otherwise conforms with the requirements for supply circuits of the same class.

(2) That the supply circuits be placed on the adjacent end pins of the bottom crossarm, and that a climbing space of at least 30 in. be maintained up the pole. Special precautions shall be taken to render such circuits conspicuous, such as painting a stripe on the crossarm or using a different form of insulator from the others on the pole line. That there shall be a vertical clearance of at least 2 ft. between the crossarm carrying these supply circuits and the next crossarm above. That the other pins of the crossarm carrying the supply circuit may be occupied by signal circuits not used for telephone and telegraph service but used in the operation or control of railway or supply apparatus.

(3) That such supply circuits shall be equipped with fuses and arresters installed in the supply end of the circuit. The fuses shall have a capacity not in excess of twice the maximum operating current value of the circuit they protect but in no case less than seven amperes. The arresters shall be designed so as to break down at a voltage of approximately twice the voltage between the wires of the circuit, but which need not be less than 500 volts. Where the supply circuits are alternating current, fuses shall be installed in the secondary side of the supply transformer which will successfully open the circuit when the voltage is as great as that of the primary voltage of the transformer.

4. Vertical Separation. In order to provide for future growth and at the same time avoid encroachments on the vertical separation, the vertical clearance between Class P-1 primary or series lighting line conductors, and Class T attachments, shall in general be at least 72 in.

In no case, however, except as specified immediately below, shall the vertical separation at the pole between Class P-1 and T attachments be less than the values shown below:
Crossarms (center to center) .....48 in.
Other attachments (crossarm braces and guys excepted) 40in.

Where cross-arm braces are attached to metal crossarms, or are in contact with transformer cases or hangers, they are subject to the same clearance requirements as the other attachments.

5. **Climbing Space.** A clear climbing space at least 30 in. wide between wires and attachments, shall be maintained up the pole. This climbing space may be on one side or corner of the pole only. Where practicable, such climbing space shall be continuous through the wires and attachments of the various classes.

On junction, corner, or other poles where additional crossarms are employed out of parallel with normal crossarms for changing the direction of the line or for banch line, and such constuction is below another class, the attachments shall be so located and maintained as to provide and keep open on one side of the pole and next to the pole, as a vertical climbing space, a square of not less than 30 in. on a side. The pole itself and crossarm back braces may be included within the climbing space so measured.

6. **Method of Supporting Line Conductors and Cables.** Where cable attachments are made directly to the pole, the full climbing space of thirty inches horizontally shall be maintained for a distance of 48 in. vertically above and below such attachment.

Class P-1 secondary conductors shall not be above, and preferably not on the same crossarm, with Class P-1 primary or series lighting conductors, except on poles carrying only one Class P-1 crossarm, in which case the secondary conductors may be carried on the same arm, but on the opposite side of the pole from the primary or series lighting conductors.

Class P-1 secondary conductors not exceeding 300 volts to ground may be carried on suitable insulators on malleable iron or steel brackets or racks, attached directly to the pole, confined to the Class P-1 space. Clearance from face of pole, specified in Section 22 of the specification, shall be observed.

Class T twisted pair distributing wires, or suspension wires carrying Class T cables or distributing wires, may be attached directly to the pole within the Class T space by malleable iron or steel fixture. Where more than eight Class T twisted pair wires are carried along the line they shall be grouped and carried in rings on a suspension strand.

Where a suspension wire carrying any cable is attached directly to the pole and is more than 24 in. below any Class P-1 attachment and less than 72 in. below the nearest Class P-1 attachment other than cable, a wooden guard-arm shall be attached to the pole immediately above and substantially parallel to such suspension wire.

The guard arm shall be at least 48 in. in length and shall be securely fastened to the pole by a through-bolt and properly braced. On corner poles, where the cable turns, the guard-arms shall be placed along the climbing side of the pole. One line conductor may be carried on a suitable bracket attached to the pole at the top by through-bolts. The use of pole top extension fixtures, except as clearance attachments on joint poles, shall in general be avoided.

7. **Conductors and Cables.** Line conductors of Classes P-1 and P-2 circuits shall be of a size not less than No. 6 A. W. G. copper. Line conductors of Class T circuits, which occupy a position above line conductors or cables of another class (except Class S circuit or Class P-1 circuits) shall be of a size not less than that required for line conductors of similar voltages when placed above Class T circuits. Class S circuits shall be not smaller than No. 8 A. W. G. copper or its equivalent in strength. Material other than copper may be used for line conductors, provided the wires of such other material have a strength not less than that of the wires specified above.

No iron or steel line conductors shall be used above line conductors or cables of another class except as noted. (1) Where above Class S. (2) Where above Class P-1 and the iron or steel line conductors are not smaller than No. 10 B. W. G. or in rural districts or arid regions No. 12 B. W. G. (3) Lightning protection wires shall be regarded as supply conductors of the voltage in connection with which they are used in respect to size, material, sag, and strength of attachments, provided, however, that they may be of galvanized stranded iron or steel of a diameter not less than 5/16 in., except in locations where corrosion of iron or steel is unusually severe.

Vertical Conductors. Wires or cables run vertically upon a pole, except above a point not less than 40 in. vertically above the highest Class T attachment, shall comply with the following requirements:

(a) Vertical conductors, except ground wires, shall have an insulation conforming to or equivalent to the requirements of the National Electrical Code for rubber covered wire, for the voltage involved.

(b) Vertical runs of Class P-1 conductors shall be carried taut down the pole by means of insulators on pins or metal brackets and securely maintained at approximately 5 in. from the surface of the pole, and if carried through Class T position shall be enclosed in conduit as specified for metal sheathed cables as in the next paragraph. Multiple conductor cable may be used for vertical runs of two or more Class P-1 conductors of the same circuit.

(c) Vertical runs of Class P-1 metal sheathed cable shall be enclosed within a conduit of suitable insulating material for its entire length, except that, where more than 6 ft. below the lowest Class T attachment, iron pipe may be used. Such conduit and pipe shall be securely fastened to the pole, and iron pipe shall be permanently and effectively grounded.

(d) Vertical runs of Class T metal sheathed cable which run through wires of another class, shall be enclosed within a conduit of suitable insulating material between points not less than 6 ft. below and 40 in. above such wires. Such conduit shall be securely fastened to the pole.

(e) Twisted pair wires from a Class T terminal box to a Class T arm or bracket may be attached directly to the pole, if within the Class T position.

(f) Ground wires which pass through attachments of another class shall be covered with a suitable protective insulating guard between points not less than 6 ft. below and 40 in. above such attachments. Ground wires shall be suitably insulated and protected from mechanical injury for at least 8 feet above the ground. Such protective covering shall be securely fastened to the pole.

(g) The same ground wire shall not be used for grounding the attachments of more than one class. Where practicable, ground wires or vertical connections to underground wires of more than one class shall not be attached to the same pole.

9. **Apparatus** Cables boxes, signal switches, cutouts and similar apparatus may be installed on the pole at a height convenient for operation, provided: (a) They do not interfere with climbing the pole. (b) The requirements as to vertical spacing are observed. (c) They do not prevent the installation of vertical runs. (d) They shall, when below attachments of another class, have all live parts protected from accidental contact. (e) Transformers shall not be located below attachments of a lower class.

10. **Pole Steppings.** Poles carrying vertical runs, lamps, transformers, cable boxes, terminals, or other apparatus which may require attention, should be provided with pole steps.

11. **Guy Insulators.** One strain insulator shall be placed in every guy at a point between six and eight feet in horizontal distance from the pole, except that, in short guys, where a point 6 ft. from the pole would be less than 8 ft. above the ground, the strain insulator shall be placed not less than eight feet above the ground.

A second strain insulator shall be placed in every guy, except those attached to a wood guy stub at a point more than 8 ft. above the ground. The second strain insulator shall be placed at a point between 6 and 8 ft. from the object to which the farther end of the guy is attached, except that, where this point is less than 8 ft. above the ground the second strain insulator shall be placed not less than 8 ft. from the ground. In anchor guys the strain insulator shall be placed between 8 and 10 ft. from the ground. In short guys, in which the two strain insulators here required would be located within 5 ft. of each other, only one strain insulator need be used.

12. **Crossarms.** Crossarms, if of selected yellow pine or fir, shall have dimensions not less than the following:

Numbers of Pins Carried	Dimensions of Cross-Section
2 or 4	3x4 inches
6 or 8	3¼x4¼ inches

If of other material, crossarms shall be the equivalent in strength and durability of the above

Appendix H—Standardization of Adhesive and Rubber Tape

The committee submitted revised specifications for friction tape with the recommendation that they be approved and substituted for the specifications now in

the Manual. It has under consideration specifications for rubber tape.

Appendix I—Standardization of Insulators

The sub-committee reviewed and revised the specifications for porcelain insulators which were tentatively adopted last year and submitted the revised specifications for adoption and inclusion in the Manual.

Appendix K—Protection of Oil Sidings from Danger Due to Stray Currents

There have been no new developments with regard to the Rules for the Protection of Oil Sidings from Danger Due to Stray Currents during the past year, and so far as is known, the installation of the proposed protection is proceeding on many railroads without confusion. The question has been raised by the Bureau of Explosives of the American Railway Association, in connection with the unloading of tank cars by the use of air pressure, with particular reference to the consideration of accumulation of static charge on account of the rapid flow of air and gasoline through pipes. It is the opinion of the committee that the provisions of the Rules for the Protection of Oil Sidings, if properly followed, will adequately take care of any static discharge.

Appendix L—Specifications for Track and Third-Rail Bonds

Inasmuch as this is the first time the subject of bonding has been considered by the committee and the fact that comparatively little has been done through any channel toward the standardization of bond practice, particularly in the field of welded type of bonds, it was necessary to give considerable study to this subject before undertaking the preparation of tentative specifications covering the various kinds of bonds that are used in heavy electric traction service.

The work of the sub-committee was confined largely to securing and tabulating data covering the latest bonding practice used in steam railroad electrifications in the United States and Canada. The results of this survey cover 21 installations of track bonds used on 18 railroads and 8 installations of third rail bonds used on 7 railroads.

Track rail bonding as well as third-rail bonding practice varies widely, even where conditions that affect the selection of the bonds are similar. Reliable data covering relative merits and performance of the different types of bonds are lacking and it is felt that further experimenting and engineering study are necessary before it will be practicable to standardize modern practice to an appreciable extent.

It was recommended that the report be accepted as progress and the subject continued with especial reference to:

Development of standard basis for measurement of bond resistance.

Securing data on current carrying capacity of bonds.

Study of details of bond design and practice for the purpose of determining to what extent standardization is practicable without interfering with the progress of the art, with a view of developing specifications covering the different classes of bonds.

Appendix M—Specifications for Incandescent Lamps

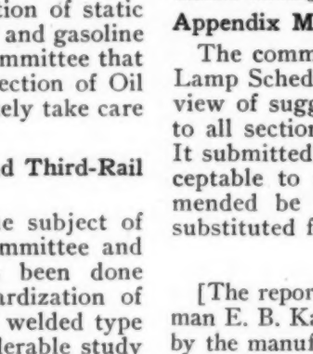
The committee reviewed and revised the Tungsten Lamp Schedule as it now appears in the Manual with view of suggesting one Schedule of lamps acceptable to all sections of the American Railway Association. It submitted a schedule which is understood to be acceptable to the Signal section and which it recommended be accepted as recommended practice and substituted for the schedule now in the Manual.

Discussion

[The report of the committee was presented by Chairman E. B. Katte. Due to certain changes recently made by the manufacturers the specifications for incandescent lamps were withdrawn by the committee with the expectation that a revised tungsten lamp schedule will be presented at the 1927 convention. The recommendations of the committee were adopted without discussion and the committee was dismissed with the thanks of the Association.]

Report on Rules and Organization

The Committee on Rules and Organization this year presented rules for the guidance of water service repairmen, building department employees, and instructions as to the painting of the interior of station buildings and telegraph offices to avoid injuring the insulation on wires and cables. It also submitted complete rules for the handling of explosives, scrap and refuse materials, procedure in case of accident, and first aid to the injured, with the recommendation that all of these rules be approved for publication in the Manual. It presented as information rules for the guidance of the different classes of employees assigned to the inspection and maintenance of work equipment. W. C. Barrett has been chairman of the committee for 6 years and a member for 7 years.



W. C. Barrett
Chairman

THE committee presented a report covering a manual of rules for the guidance of employees of the maintenance of way department, (Appendices "A" and "B"). It recommended that the rules of Appendix "A" be approved for printing in the manual, and that those in Appendix "B" be received as information for publication in the proceedings.

Committee: W. C. Barrett (L. V.), Chairman; E. H. Barnhart (B. & O.), Vice-Chairman; M. M. Backus (I. C.), D. P. Beach (Penna.), H. L. Browne, E. N. Burrows (Cornell Univ.), P. D. Coons (C. B. & Q.), J. H. Davidson (M-K-T), Arthur Daniels (C. M. & St. P.), J. L. Downs (I. C.), J. M. Fair (Penna.), P. O. Ferris (D. & H.), W. J. Foster (Erie), B. Herman (Sou.), H. H. Harsh (B. & O.), J. L. Jamieson (C. P. R.), B. R. Kulp (C. & N. W.), E. F. Manson (C. R. I. & P.), J. A. Peabody (C. & N. W.), R. N. Priest (A. T. & S. F.), H. J.

Pfeifer (T. R. R. A.), E. M. Smith (B. & M.), J. W. Stephens (N. Y. C.), C. H. Tillett (C. N. R.), R. E. Warden (N. P.), F. B. Wiegand (N. Y. C.), C. R. Wright (N. Y. C. & St. L.).

Appendix A

Water Service Repairmen

(Compiled in collaboration with Committee on Rules and Organization.)

510. Water service repairmen report to and receive instructions from the supervisor of water service.

511. They will have immediate charge of helpers, laborers and all other forces under them and will exercise general supervision over pumpers on their districts or assigned territory. They must keep such records as the supervisor of water service may direct and make the required reports of work done and of the receipt, distribution and use of material furnished them.

512. They will have charge of and be responsible for the proper maintenance of water stations, including wells, pipe lines, tanks, water columns, heating plants, windmills and other facilities used in connection therewith. They will be responsible for the maintenance of plumbing, heating and such other facilities as the supervisor of water service may designate. They will be responsible for the proper maintenance of fire pumps, hydrants, hose and other facilities required for protection against fire (exclusive of fire extinguishers, water barrels and buckets) except at locomotive terminals where fire protection facilities are handled by the mechanical department.

513. They will have charge of and be responsible for such tools and materials as are necessary for the performance of their work and must know that these are properly used. They must advise the supervisor of water service of the necessity for materials well in advance of the actual need.

514. When necessary to take out of service any water tank, water column or other facilities affecting the water supply or the operation of any other department, either temporarily or permanently, repairmen will notify the supervisor of water service and must not—except in emergency—proceed with the work until the proper authority is obtained. If any emergency exists, they must notify the supervisor of water service and chief dispatcher by wire. Proper notice must be given when the facility is restored to service.

515. They must at all times keep the supervisor of water service and the chief dispatcher advised of their movements so that they may be available in case of an emergency.

Buildings

(Compiled in collaboration with Committee on Buildings.)

1661. Before depositing new concrete on or against concrete which has set, the surface of the latter must be roughened, thoroughly cleaned of foreign material and saturated with water, and a thick coat of rich grouting spread over the surface *immediately* before placing new concrete.

1662. In patchwork first concrete should be placed with force by throwing from a paddle and allowed to harden undisturbed. The first concrete should be kept wet until thoroughly hardened. Patches should be built up by successive application in same way.

1663. Common and face brick work must be laid even and true to line, plumb and level. Brick should be thoroughly wetted either by immersion or sprinkling before laid, except in freezing weather.

1664. All brick courses should be proportioned so that they will work out evenly with heights of windows and doors without split or fractional courses.

1665. The mortar must be thoroughly mixed and used at once. No mortar which has frozen or hardened beyond the point of reworking into plastic mass shall be used.

1666. Centers of approved type must be provided for all openings. They must be well supported and rigidly braced, so as to properly carry the load until the brick work has set.

1667. All openings, anchors, bearing plates, ties and nailing blocks must be properly located.

1668. Brick flues must have an approved form of fireproof lining so located as to reduce fire hazard; brick flues not provided with fire brick lining must be provided with terra-cotta flue lining and all joints in this lining must be completely filled with mortar. The fire hazard must be considered in the design and location of all flues. Special precautions must be taken, where new masonry work joins up with old masonry work, to see that the old work is sufficiently bonded, anchors provided and work keyed so that an absolutely tight and neat bond is assured between old and new work.

1669. All mill work and finished lumber must be protected from the sun and rain until used. Framing must be done to give close joints. All corners and angles must be solid and well braced.

1670. Joists must be of the dimensions and spaced as shown on the plans. Joists must not be levelled on wooden blocks or chips. Headers and trimmers must be of sufficient strength to carry the load.

1671. Roof trusses must be framed and built in strict accordance with detail plans, accurately fitted and securely nailed, spiked or bolted. Chords of trusses should preferably be of one piece and must be set level, plumb and securely braced longitudinally and in the planes of the top chord. Trusses must be framed with the proper camber. Rafters and purlins must be accurately set with solid bearing over the wall plates or beams and securely fastened at all points. Sheathing must be of uniform width, securely fastened at every bearing and the joints broken on the rafters.

1672. Siding must be placed horizontal with tight square butt joints fitted closely and accurately against all casings and sills.

1673. Flooring must be laid in even lengths, and must be securely fastened and joints broken on joists.

1674. Window and door frames must be set true and plumb, braced, protected and securely anchored.

1675. Stairs must be built strongly and rigidly to meet local conditions and when exposed to the weather, treads provided with proper pitch.

1676. Flashing must be properly placed to insure roof from leaking.

1677. Guarantee of ready prepared roofing should not be fully relied on to give proper results. Records of service must be kept to see that the guarantee is being carried out.

1678. Downspouts and gutters should be placed outside the building whenever possible and must be protected against damage, and cleaned regularly.

1679. Green lath must not be used. Lath must be moistened before plaster is applied. Metal lath used in a damp or salt climate must be painted or back plastered.

1680. Lath must be securely fastened at every bearing with broken joints and no lath should extend beyond any corner or angle.

1681. Proper temperature must be maintained to prevent plaster from freezing. Lime and cement must be stored in a dry place until used.

1682. All openings in walls must be made before plastering.

Painting

(Compiled by T. & T. Section, A. R. A., in collaboration with Committee on Rules and Organization, A. R. E. A.)

1717. When painting the interior of station buildings and telegraph offices, care must be used not to paint insulated wires and cables, because of the deteriorating effect of ordinary paint on insulation.

Handling Explosives, Scrap, and Refuse Material

Scrap and Refuse

3000. Wornout and unserviceable tools must be turned into the stores department, according to instructions.

3001. Salvageable scrap will be picked up and stored at designated points for disposition.

3002. Track ties, head blocks and switch ties removed should be piled adjacent to the track and culled before final disposition.

3003. Material and rubbish from repairs of bridges, buildings, trestles, culverts, telegraph lines, fences, etc., must be cleaned up as soon as the work is completed. Material of a usable nature must be placed in a convenient pile for loading. If rubbish is burned see that the fire is at a safe distance from all structures.

3004. Material piled for inspection or loading must be placed at a safe distance from the track.

3005. Rubbish and waste from station grounds, buildings and freight houses which cannot be burned should be buried or otherwise disposed of as directed.

3006. In burning refuse when incinerators are not available the fire must not be left unattended or started unless sufficient force is at hand for keeping it under control. The fire must be put out before leaving.

Explosives—Dynamite

3025. Danger signs must be conspicuously placed on all buildings and magazines in which explosives are stored. The supervisor must be familiar with the state and federal laws and local regulations covering the transportation and storage of explosives. He must see that these requirements are understood and obeyed by the employee delegated to handle the explosive to be used.

3026. Dynamite, powder and other explosives shall be stored in fireproof magazines located at a safe distance from the company buildings, or buildings and property of others, in accordance with the law, and where they are not liable to be interfered with.

3027. The supply in storage should be kept at the minimum for the requirements and be removed in small quantities as needed.

3028. Fuses and caps must in no case be stored in the same building with explosives.

3029. No man should be assigned to the handling of these

explosives who is not able to satisfy the supervisor of his qualifications and previous experience in their use.

3030. Employees must not strike or light matches while handling explosives. An employee shall not carry a lighted candle or other fire while handling dynamite or other explosive supplies. No explosives may be brought within five feet of any lantern or enclosed fire.

3031. Under no circumstances may an employee permit dynamite, detonators or other explosives he may be handling to be placed near a fire or within range of flying sparks, even though the explosive is packed in a strong tight box.

3032. When frozen, dynamite may fail to explode or explode with little force, and in either case a whole or part of the charge may be left in the "bore" hole or mixed with broken rock or dirt. Such dynamite is liable to explode if struck with a shovel or other tool and cause personal injury or loss of life.

3033. Dynamite is likely to freeze when its temperature falls below 50 deg. F. and dynamite of such temperature must be considered as frozen and thawed before using.

3034. Dynamite may be thawed by using an approved kettle or by placing it in a tight box and burying it in fresh manure.

3035. In thawing dynamite with an approved kettle: First, fill the water compartment with water of such temperature that it will not be higher than 100 deg. F. when the dynamite is put in the compartment provided for it. Second, place the dynamite in the compartment provided for it after ascertaining that the compartment is clean and dry.

3036. Do not place dynamite in the kettle when the temperature of the water is above 100 deg. F.

3037. Do not place the thawing kettle near a lighted lantern or a fire of any kind.

Inflammable Oils

3050. All gasolines evaporate rapidly in hot weather, but even in the coldest weather gasoline gives off inflammable vapors in sufficient amount to ignite readily. This vapor is heavier than air and tends to form a layer along the ground and only mixes slowly with the air.

3051. Gasoline and other similar fuels for use in pumping plants, motor cars, etc., must be kept in tanks buried in the ground and properly ventilated. These tanks must never be filled by open lamp or torch light. Lighted matches, pipes or cigarettes must be kept away from these tanks.

3052. Oil-soaked rags or waste often cause spontaneous combustion. Do not allow these to accumulate.

3053. Fuses, torpedoes or matches must be kept or carried only in containers provided for their protection.

3054. Do not use water on an oil fire. Smother if possible with dry earth, steam or wet blankets.

3055. In case of wrecks involving tank cars of inflammable oils the Section Foreman should be specially careful to:

(a) Police the location.
(b) Cause the removal or prevent the approach of all lights or fires other than closed electric lights.
(c) Keep all unauthorized persons away.

Appendix A also included rules for Procedure in Case of Accident, and First Aid to the Injured, which were too long to reproduce here.

Appendix B

General Supervisor of Work Equipment

1. The general supervisor of work equipment will report to and receive instructions from the chief maintenance of way officer.

2. He will be in charge of the maintenance and repairs to the following equipment on the system: Ditching machines, steam shovels, pile-drivers, locomotive cranes, rail-handling machines, tie tamping machines, spreaders, ditcher-spreaders, disking machines, mowing machines, weed burners, motor cars, camp cars, air dump cars and concrete mixers.

3. He will be responsible for all such equipment and will see that it is in condition, at all times, for efficient service.

4. He will handle the distribution and transfer of all such equipment to and from the various divisions.

5. He will keep such records of the performance of each machine, including the labor and material expended in operating, maintaining and repairing, so that he will know the efficiency of each machine.

6. He shall recommend the purchase of new machines and shall pass upon the retiring and dismantling of obsolete equipment.

7. He shall know the location of each machine, and shall arrange for a system of numbering, so as to keep proper records, as hereinbefore provided.

8. In an emergency, requiring the quick dispatch or transfer of any machine, the Division Engineer will make request upon the General Supervisor of Work Equipment.

Inspectors of Work Equipment

1. Inspectors of work equipment report to and receive instructions from the general supervisor of work equipment.

2. They will perform such duties as may be assigned to them and will act in an advisory capacity to the supervisors of work equipment.

Supervisors of Work Equipment

1. Supervisors of work equipment report to and receive instructions from the division engineer.

2. They will be in charge, on their respective divisions, of such work equipment as may be under the general supervision of the division engineer.

3. They must report their movements daily to the division engineer and chief dispatcher.

4. They will be responsible for the operation and maintenance of all equipment while under their charge.

5. They must see that the repairmen are properly equipped with tools and supplies, that they perform their work efficiently and make proper reports.

6. They must make a quarterly inspection of all work equipment, reporting on the prescribed form to the division engineer, stating the condition and when repairs will be necessary.

7. They must make a monthly report of the performance of work equipment under their jurisdiction, giving the amount of work accomplished, cost of fuel, lubricants and other supplies necessary to run the machines and the cost of repairs.

8. The division engineer must be notified when it becomes necessary to take any work equipment out of service. Prompt notice must be given when it is again ready for service.

9. They will keep a daily record of the location of each machine, together with such records of performance as are necessary to make the required reports.

10. They must see that work equipment repairmen and operators make the required reports on the costs of repairs and operation of the machines under their charge.

Work Equipment Repairmen

1. Work equipment repairmen report to and receive instructions from the supervisor of work equipment.

2. They will have immediate charge of helpers, laborers and all other force under them engaged in the maintenance of work equipment.

3. They will keep such records regarding the cost of repairs to work equipment and other roadway machines as the supervisor may direct and make the required reports of work done and of the receipt, distribution and use of material.

4. They will have charge of and be responsible for the proper maintenance of all work equipment and roadway machines on their assigned territory.

5. They must know the exact condition of the work equipment and roadway machines under their jurisdiction, making an inspection of them at every available opportunity.

6. They will have charge of and be responsible for such tools and material as are necessary for the performance of their work and must know that these are properly used.

7. Work equipment and roadway machines, including motor cars, must not be shipped to the equipment shop for repairs unless repairs are of such nature that they cannot be performed economically in the field.

8. Equipment in unsafe condition must not be permitted to remain in service.

Work Equipment Operators

1. Work equipment operators report to and receive instructions from the supervisor of work equipment.

2. They will have charge of any helpers assigned to their machine.

3. They will make the required reports covering the operation of the machine as the supervisor of work equipment may direct and will forward them as instructed.

4. They must know the exact condition of the machines under their charge; that they are in proper condition to do the work efficiently, and if, in their judgment, such machines are not performing efficiently, they must notify the supervisor, in detail, wherein they are not in condition.

5. They will have charge of such tools and equipment as may be assigned to them and if any such tools are not in proper condition, must notify the supervisor of work equipment.

6. They must not ship a machine to a shop for repairs except upon proper authority from the supervisor of work equipment, but when such machine is forwarded, they must see that it is properly prepared for safe movement and in case an operator does not accompany the machine, all brass and other valuable parts, easily removable, should be taken off, boxed and shipped separately.

Discussion

The report was introduced by Chairman Barrett and subject No. 2, Manual of Rules for the Guidance of Employees in the Maintenance of Way Department was presented by Vice-Chairman Barnhart. The first rules

covering water service repairmen, were accepted without discussion. The rules covering buildings were then presented.

A. F. Blaess (I. C.): It seems to me that comes under the scope of specifications instead of rules.

Vice-Chairman Barnhart: That subject has been one that has been up with the committee for a number of years. We generally take the approval of the standing committee as to whether they are specifications or whether they are rules. The Building Committee passed upon these as rules.

C. W. Baldridge (A. T. & S. F.): I hardly think that this matter belongs in the list of rules. If you will read them through, you will find that all but two of these proposed rules are instructions as to how work shall be done, without any regard as to who is going to do it. My understanding of a rule would be instructions to an individual or a group of individuals as to their duties and how they are to be performed. This matter should have been presented by Committee No. 6 on Buildings as specifications, and I *move that it be referred back to Committee No. 6 for inclusion as specifications.*

Chairman Barrett: This Committee has found it very difficult to draw a line between what are instructions and what are rules. These rules were gone over very carefully by the Committee on Buildings and approved by them for use by this committee as rules. They are not specifications and in view of the fact that all of the rules we could submit would be general I hardly see how we could make any specific rules for any specific individual.

O. E. Selby (C. C. C. & St. L.): I agree with the two speakers from the floor that the rules on buildings are not proper subjects for inclusion in the Manual in this place, under this committee. The rules presented are not rules for guidance of employees. These are specifications and to my mind incomplete, attempting to cover in less than two pages the whole realm of building instruction. Some of the specifications are already in the Manual and in the reports of other committees. I see no good reason for repeating them here. .

It would be better to insert under buildings merely rules for the employees and not attempt to cover special cases for building work.

Chairman Barrett: I think a close study of these rules will indicate to any one that they are not specifications. The idea that the committee had in mind was to take all of the material it could find in collaboration with the Committee on Building and boil down into a few simple rules the fundamental things which a builder should do under the proper specifications when he is putting up his building.

Every one understands this manual of rules for the guidance of employees of the Maintenance of Way Department can never be complete. This is the start on presenting or printing in the manual rules covering instructions on the maintenance of buildings, and these rules were never intended to be and are not specifications.

The motion to refer the rules back to the committee was seconded.

W. C. Cushing (Penna.): The maintenance of way department is a part of the operating department of the railroad. The book of rules of the operating department is the general statement of rules to conduct and the duties of the employees who hold positions as heads of some departments. There should be no other duplication of those rules or instructions in any other books that are issued by the various departments. The book of rules for the Maintenance of Way Department should be a supplementary book to it and should not contain the same substance.

I have noticed in the different reports of this committee from time to time a great deal of that repetition. It takes up space and requires reference to more than one place for ascertaining the duties of employees. My view would be to recommend a back track on the part of this committee to correct its plan of work.

You will find an immense amount of repetition. Pretty nearly every employee has certain rules of conduct which are the same for almost every one of them, and you will find that in the various rules of the Manual already published those things are repeated over and over again, whereas they are also contained for the most part in the book of transportation and book of operation already published. My suggestion would be that the committee should work on that line instead of the present line that it is pursuing.

Mr. Barrett: In answer to Mr. Cushing's suggestion, I might just state that so far as we know the Committee has worked directly along the lines laid down for us by the Board of Direction of the Association.

L. P. Kimball (B. & O.): As I understand the purpose of the Association in assigning such a subject to the committee, it is to result in the eventual completion of an independent book of rules for the maintenance of way department, independent in the sense of being published perhaps separately from the Manual, at least when complete, and as such I think it is entirely proper to include material of this nature in that book of rules, even though it is a repetition in some instances of material which has been prepared and published in the specifications by the Building Committee.

J. P. Hanley (I. C.): It appears to me that these are rules on the conduct of work. The committee did a great deal of work, and I believe it would be a good idea to leave these things in as recommended good practice.

Mr. J. L. Campbell (S. P.): The point at issue is brought out by the comparison of the rules which have been submitted for the guidance of the water service department with these specifications. It has been my contention that the rules which would be submitted by the committee should have reference only to the organization that would do certain work.

It seems to me that the rules for water service employees refer to the organization, not the actual conduct of work under the organization, but for the guidance of the employees of that organization; but when we come to the rules for the employees on buildings, we have nothing but specifications for doing the work.

Hunter McDonald (N. C. & St. L.); I want to endorse what Mr. Cushing and Mr. Campbell have said with respect to this report. I had noticed that the rules for Water Service Repairmen had dealt only with the conduct of the individual, while I think the specifications for buildings encroach upon the field of the architect and should be under specifications.

Mr. Barrett: I would like to call the attention of the members to Bulletin 279 which contains a supplement to the Manual, which is the report of this committee for last year, with particular reference to the fact that the report is divided into two distinct parts. The first is the duties of the various divisional officers and employees and the second is conduct of work. The reason for the great difference between the rules on page 66 and the rules beginning on page 67 is that the former rules are for employees, instructions to the individuals, while the latter rules under buildings are for the conduct of work.

Report on Shops and Locomotive Terminals

The Committee on Shops and Locomotive Terminals presented reports on general layouts for engine terminals and on general layouts and designs of passenger car repair shops, with the recommendation that both reports be approved for publication in the Manual. It also presented for adoption a report on the ventilation of engine houses. The report called attention to the relation of the heating system to the ventilation of the engine house and recommended a hot blast heating system for general use. It presented a progress report on storehouses for shops and locomotive terminals in which the governing conditions to be considered in the layout and design for such facilities are outlined. F. E. Morrow has been chairman of this committee since its organization.

F. E. Morrow
Chairman

THE Committee presented a report covering the following subjects: (1) General Layouts of Engine Terminals (Appendix "A"); (2) General Layouts and Designs of Passenger Car Repair Shops (Appendix "B"); (3) Ventilation of Engine Houses (Appendix "C"); and (4) Storehouses for Shops and Locomotive Terminals (Appendix "D").

The committee recommended: (1) That the conclusions in Appendix "A," relating to the General Layouts of Engine Terminals, be approved for publication in the Manual; (2) That the conclusions in Appendix "B," relating to General Layouts and Designs of Passenger Car Repair Shops, be approved for publication in the Manual; (3) That the conclusions in Appendix "C," relating to Ventilation of Engine Houses, be approved for publication in the Manual; and (4) That the report in Appendix "D," relating to Storehouses for Shops and Locomotive Terminals, be received as information.

Committee: F. E. Morrow, (C. W. I.) chairman; A. T. Hawk, (C. R. I. & P.) vice-chairman; J. B. Akers (Sou.), C. I. Anderson (I. C.), A. Lee Atwill (C. & W. I.), C. N. Bainbridge (C. M. & St. P.), Leland Clapper (D. & I. R.), J. W. Dansey (A. T. & S. F.), K. B. Duncan (G. C. & S. F.), R. J. Hammond (B. & M.), George W. Hand (C. & N. W.), G. W. Harris (A. T. & S. F.), J. L. Haugh (U. P.), L. P. Kimball (B. & O.), W. H. Kirkbridge (S. P.), W. T. Krausch (C. B. & Q.), H. M. Lull (S. P.), R. A. Marshall (Dwight P. Robinson Co.), J. S. McBride (C. & E. I.), J. M. Metcalf (M.-K.-T.), G. A. Noren (N. Y. C.), D. A. Porter (S. P.), V. B. W. Poulson (C. & O.), J. W. Raitt (N. & W.), L. K. Sillcox (C. M. & St. P.), John Schofield (C. N. R.), B. S. Voorhees (N. Y. C.), H. W. Williams (C. M. & St. P.), A. M. Zabriskie (C. of N. J.).

Appendix A—Engine Terminal Layout for Steam Locomotives

Engine terminals are provided so that the mechanical forces may care for and repair engines and furnish the transportation forces a supply of engines in good condition. To maintain the supply, engines must be handled through the terminal in the shortest possible time, or additional engines assigned to the district.

The development of steam locomotives in weight and tractive power has been so rapid during the past 10 or 15 years as to make the engine terminal a particularly important field for investigation looking toward the effecting of economies. The rapid advance in locomotive design is evidenced by the increase in revenue tons hauled per train mile from 380 in 1910 to 632 in 1923, or about 66 per cent.

While the greater portion of the time an engine is at a locomotive terminal is due to the time necessary in making repairs or waiting for trains or crews, an improperly laid out terminal will not only retard the movement of engines at all times, but will increase the most of hostling, and in times of peak business may become the controlling factor in the amount of business which can be handled.

In order that the time locomotives are held at a terminal may be reduced to a minimum the locomotive terminal itself must be coordinated with all other facilities so that the movement of engines may be orderly and expeditiously made from the time engine is detached from its train in the yard or at the station until it is again attached to a train, its fires cleaned, coal, water and sand taken, oiled, wiped, and any needed repairs made, ready in first-class condition, to haul its full tonnage rating to the next terminal.

While an engine terminal designed for the orderly and expeditious movement of engines should reduce the time required by the mechanical forces to a minimum, it should be also borne in mind that unless traffic conditions are such that the engines can be used as soon as available, no saving will be accomplished by shortening the terminal time, and that the layover of assigned engines is fixed by schedules.

In order that the engine terminal design may meet all the requirements of a particular location, the cooperation of the operating personnel is necessary.

In order that facilities for proper capacity and spacing may be provided, a thorough study of the traffic to be handled, both for the present and in the future, must be made, for which the following information is necessary:

(a) Type and size of engines to be handled.
(b) Number of locomotives handled in each direction daily by classes.
(c) Schedule of arrival and departure of locomotives by classes.
(d) Number arriving during peak period.
(e) Time within which engines arriving must be hostled by classes.
(f) Maximum number of engines on terminal at one time.
(g) Number engines repaired daily by classes of work.
(h) Number engines under repair at one time by classes of work.
(i) Amount of fuel (coal or oil) issued daily.
(j) Amount of water consumed daily.

(k) Amount of sand consumed daily.
(l) Number of men required to operate the terminal.

While the time required for the movement of an engine from the terminal entrance to the engine house will vary greatly, depending upon the climatic conditions, fuel used, the size of the engine, length of run, class of service and amount of work done at the particular terminal, and this must be determined for each specific location, an average for all will be approximately:

From Terminal Entrance to First Facility..	5 min.
Outside Inspection	30 min.
Cleaning Fires	45 min.
Taking Coal, Sand and Water	15 min.
Outside Washing	15 min.
Onto Table—Turning and Into House	4 min.
	1 hr. 54 min.

The movement between facilities depends upon capacity of facility, number of men, etc.

With the above information, after making allowances for the probable increase in traffic, changes in operating conditions and methods, etc., a diagram can be drawn for each engine movement, and the capacity of each facility, spacing between facilities and the time required for hostling each engine determined. This will permit the designing and spacing of the various facilities of the terminal for the orderly movement of engines from the entrance to the house.

In view of the expenditure necessary to provide a modern engine terminal, no terminal should be designed without providing for future expansion, so that it may be made with minimum changes to the original plant.

After a thorough study as to requirements has been made and the capacity of the various parts of the facility determined the adequacy of different proposed sites can be determined, and a layout made, adapted to the topographical conditions.

The committee called attention to the requisites to be considered in the selection of the site, track layout, inspection pits and facilities for water, coal or fuel oil, ash pits and sand, as well as for the enginehouse, turntable, boiler washing system, repair facilities and other adjuncts, concluding with the following recommendations:

1. In designing an engine terminal layout, a thorough study of the traffic and operating requirements of the terminal should be made jointly by the engineering, operating and mechanical departments.
2. A terminal should be designed not only for present requirements but also to permit future expansion.
3. Sufficient and properly laid out trackage should be provided to permit the prompt receipt of all engines immediately upon arrival and in advance of each facility for standing locomotives which may have to wait their turn, and so arranged as to provide for the orderly and expeditious movement of engines between the terminal entrance and the house.
4. The required facilities should be provided and placed in proper sequence.

Appendix B—General Layout and Design of Passenger Car Shops

The report of the committee this year is in conclusion of the progress report rendered in 1922, in which definite suggestions are offered as recommended practice. A study of the subject was made by the Mechanical Division of the American Railway Association and covered by a committee report in the 1925 Proceedings.

Viewing present prevailing passenger car maintenance, practices and policies in a comprehensive way, the committee was impressed with the following considerations, which should be borne in mind:

(1) That a constantly greater recognition obtains and continues on the part of the various administrations concerning the importance of what may be termed higher class traffic, involving the more complicated designs of cars, such as diners, observation cars, club cars, etc. This to a lesser degree is being extended to coaches where it is now found that modern plumbing, proper lavatory facilities with every convenience are demanded as compared to the less elaborate applications contained in coaches used in the recent past.

(2) The physical condition of such equipment is being followed up more closely, and at the same time serious attention is being paid to maintaining the cars properly, but endeavoring to do so within the cost limits of the past; in other words, doing more and better work for the same cost. This has resulted in increased study being given shop methods, materials of construction, and facilities for handling repairs.

(3) There seems to be acceptance on the part of all administrations with respect to the operation of equipment having the required strength for safety with the result that where obsolete cars are not retired, a reinforcing program is instituted. This trend appears to be progressing gradually throughout the country rather than subject to programs involving a quick and possibly more intensive turnover. The result has also been to obtain greater utilization of cars where uniform strength of all classes, and units in each class, obtains, making it possible to use any car in any service, provided, of course, the maintenance is disposed of in a uniform manner.

(4) More self-propelled cars for branch line, local and other service are being pressed into use constantly, and the rise in the rate of acquisition has been very marked of late. If this class of equipment is to be promptly handled and without divided responsibility, a greater burden in the care and rehabilitation of the mechanical apparatus will be placed on the car department, such as has developed, for instance, in the care of electric lighting equipment on cars. This may require certain arrangements being made in the car shops, such as the provision of machine tools, inspection pits between tracks, testing facilities, etc.

(5) For the sake of economy and to allow intensified administration, passenger car repairs are being concentrated more and more in shops designed to meet present-day requirements. This has been brought about very largely from the fact that the older shops have stalls insufficiently high and not of adequate length to properly care for equipment of modern dimensions, necessitating either the rehabilitation or involving new construction to provide clearances prescribed by present trends of design. Shop buildings are being limited to the least number required, resulting in those which are employed having the various departments grouped convenient to the work on the cars themselves to meet the requirement as to intensive use of facilities. The committee has made a definite recommendation along this line with a view toward emphasizing the importance of this fact and thus reduce shop overhead or handling expense to a minimum, being a labor item which does not in any physical way improve the equipment.

Layout

The layout and design from the standpoint of eco-

nomical operation will depend largely on the capacity required by the individual road, as well as upon the type of equipment owned, with due reference to future acquisition. As the capacity must first be settled upon before the layout may be attempted, its determination is the logical starting point. The determination of capacity involves: the number of cars of each type; the policy as regards condition when general repairs are deemed necessary; the average age as well as degree of structural and design obsolescence obtaining; and the seasonal demands for equipment of certain classes.

The number of cars of each class enters the problem to the extent that unless the ownership is quite evenly divided as to number of each class, certain departments may have to be larger than otherwise would be required and possibly to the extent of increasing the size of shop for desired output.

The shopping policy, of course, establishes the repair cycle or frequency of shopping and has a direct bearing on the capacity of shop that must be provided, as it is evident, for instance, that double the output must result where cars are shopped on a 15-months basis than on a 30-months basis.

On roads where the demand for equipment is nearly uniform throughout the year, the shopping of equipment may be handled in an ideal manner, provided the shop layout is well considered and properly proportioned. However, there are few railroads so favorably situated that seasonal demands are not of considerable moment. Where a large number of cars of any one class must be repaired in a comparatively short period of time, a very uneconomical shop operation is most likely to result, as it is not possible to keep a well-balanced organization. Desirable labor cannot be obtained where steady employment cannot be assured and the continual disrupting of the organization will react on the efficiency to a marked degree, both in quality and quantity of output. Where the seasonal demand problem must be reckoned with, it is suggested that consideration be given to the manufacture of certain parts of a more or less standard type against the arrival of the cars at the shop. By providing, in advance, such parts as trucks, foundation brake gear members, car seats, piping, upholstery, curtains, sashes, doors, screens, head linings, water coolers, wash stands, mirrors, trap doors, steps, trimming, carpet, battery and lighting equipment, ventilators, etc., the shop organization may be kept quite uniform and at the same time result in the equipment being held out of service for repairs a minimum of time. Such an arrangement would appear to offer a step toward a possible solution to the difficulties of car shopping arising where seasonal demands are quite pronounced.

An efficiently organized and maintained system of scheduling repairs through the repair shops has an important bearing on the shop capacity. Unless such a plan is in effect and rigidly enforced, the shopping capacity required will of necessity have to be larger than would otherwise be necessary, and repair costs will likewise be greater. The work should progress in logical sequence through the shop and the layout must be such as to make this possible.

In laying out the new shop, after the capacity has been determined, ample provision should be made for future expansion, even to largely governing the selection of site. Very frequently, with old layouts, proper consideration was not accorded this feature, with the result that, where conditions now demand greater capacity or enlarged dimensions to accommodate large equipment, the condition cannot be met without sacrificing much of the advantage of proper sequence of operation. The general layout should be such that any or all departments may be logically expanded as occasion demands, and due consideration accorded the possibility maximum length passenger train cars. Judging from past experience, it can safely be said that future cars will be heavier and of the maximum length permitted by roadway restrictions.

The shop layout should take into account the fact that steel is coming into more general use to replace wood as formerly used. Provision for handling this class of material is necessary, bearing in mind that the rehabilitation of equipment will make necessary more or less fabrication of steel parts for underframing as well as side sheets and interior finish. Generous shop space is recommended for this purpose, whether the work is carried on under supervision of the tin shop or whether a separate department may be deemed desirable.

The committee presented recommendations as to types of construction and the elements to be considered in the design of coach shops, paint shops, wheel shops, truck shops, inspection facilities, storehouse facilities, toilet and washroom facilities, wood mill and power house, concluding with the following recommendations:

1. Suitable provision to be made for future expansion of all facilities. 2. Capacity should be determined on basis of number of cars to be shopped in a given time, balanced against traffic demands and effect of manufacturing operations. 3. All buildings to be of substantial fireproof construction, amply lighted, both natural and artificial; comfortably heated and well-ventilated. 4. Tracks in the coach shop should have a minimum spacing of 24 ft. center to center, except where columns are located between tracks, when 12 ft. from face of column to center of track should be provided. 5. Tracks in the paint shop should have a minimum spacing of 20 ft., unless local conditions make it desirable for these tracks to line up with the coach shop. 6. Minimum spacing in the stripping and trimming shed should be 20 ft. and in the truck shop 15 ft. 7. The overhead clearance in coach shop should be not less than 22 ft. to the bottom chord of roof truss. 8. The width of coach shop should not be less than the length of longest car plus 27 ft. 9. The width of paint shop should not be less than the length of the longest car plus 20 ft. 10. Doors should provide a clear opening of 14 ft. by 17 ft. unless otherwise prescribed by law. 11. Generous use of cranes, hoists and monorail is desirable. 12. The layout should be such that all operations follow in logical sequence so far as possible. 13. Manufacturing departments should be grouped as conveniently as possible to the point where the respective parts are applied. 14. Main and sub-storehouse should be located as centrally as possible to the departments they serve. Sufficient sub-storeroom should be provided as to provide material reasonably close to the shop operations. 15. Paved roadways and walks of ample width are highly desirable. 16. Ample storage space for cars to be shopped, as well as finished cars, is essential. 17. Separate inspection facilities are desirable. 18. Special provision should be made for preventing and fighting fires.

Appendix C—The Ventilation of Engine Houses

General—The following are recommendations for general practice in the ventilation of engine houses.

They do not apply to houses which are equipped with a mechanical system for smoke removal, consisting of special jacks, ducts, fans and stack. Such a system is not recommended for general use in connection with ventilation.

Smoke Jacks—Smoke jacks should be of the fixed type, at least 42 in. wide, and of such length (preferably at least 12 ft.) as to receive the smoke from the stack at its limiting positions, due to the adjustment of the driving wheels to bring the side rods in proper position for repairs. The position of the jacks in the roof should be established with the above condition in view and the elevation of the bottom of the hood should be 16 ft. 6 in. at the ends and 15 ft. 6 in. at the sides above the top of rail. The area of flue opening should be at least 7 sq. ft. An annular space 2 in. in width should be provided around the flue. A locomotive entering the house should be spotted with the smoke stack under the jack as rapidly as consistent with safe handling and should always be kept in such position while under fire.

Steam Blowoff—Provision of a proper system of piping for blowing off steam from boilers should be made in every engine house. Where possible the steam blown off should be used for heating purposes in connection with a boiler washing system, but in all cases discharge should be made outside the limits of the engine house. A ventilator of standard design and at least 18 in. in diameter should be placed in the roof on the center of each stall and as nearly as possible over the center of the steam dome of locomotives handled. This ventilator should be provided with an extension if necessary so as to place it above the highest part of the roof. If regular blowoff piping is temporarily out of service, arrangements should be made to blow-off through portable pipe into this ventilator and the blowing off of locomotives without such provision should be absolutely prohibited.

The features above mentioned will, as heretofore stated, reduce the necessity for other ventilation provisions, but, as with the best of care in operation some smoke and steam will escape, the following additional recommendations are considered essential.

Cross-Section of House—As modern engine houses have stalls generally 100 ft. or more in depth, at least one break should be made in the roof and if desirable complete monitor may be installed. Such breaks or monitors should be provided with pivoted sash or a combination of pivoted sash and fixed louvres, depending upon the climate.

Framing—Roof framing should be such that the rafters directly supporting the sheathing or other roof surface are in radial lines and without pockets so as to permit the free passage of smoke to the eaves. At the high eaves directly under the roof sheathing, if climatic conditions will permit, a continuous opening of four to six in. should be provided to permit the escape of smoke and steam, particularly at breaks and in monitors.

Windows—Large windows should be provided in the outer walls with a generous provision of ventilating sections. As near a continuous row of these ventilating sash as practicable should be provided along the top of windows.

Heating—The relation of the heating system to the ventilation of the engine house is of course apparent. The provision of a hot blast heating system with supply of air taken either from outside or inside of house as conditions may require and circulation by means of underground ducts with outlets in pits and along the outer wall just above floor level is recommended for general use. Such a system designed for frequent air changes will result in the rapid clearing of atmosphere in house even under unfavorable conditions. The use of this equipment during the summer months will materially lower the temperature in the house as well as clear the atmosphere in same.

Appendix D—Storehouses for Shops and Locomotive Terminals

The committee assignment was limited to storehouses for shops and locomotive terminals. In practice very often the storehouse for these facilities is combined with the system district or division storehouse, and even when this is not the case the storehouse may serve several shop and terminal facilities. In view of these conditions only the most general requirements can be given. Also, the size and location will be governed by the services required.

The subject of storehouses is taken to include not only the storehouse proper but all auxiliary facilities, consisting of oil storage, material platforms, paint stores, lumber storage yard and sheds, material racks, sheds for coal, coke, charcoal, fire brick, locomotive arch brick, storage or generating of oxygen and acetylene, scrap dock and reclamation sheds.

Track facilities should be provided for the receipt of incoming materials, for the loading out of materials, for distribution to other points and shipment of scrap. Paved roadways should connect the storehouse with public highways and all parts of the shops and terminal served by the storehouse. These roadways not only serve in the distribution of materials, but also provide easy access for fire apparatus.

Main Storehouse

The primary consideration is the economical handling of material. The arrangement should be such as to insure ample natural light, the convenient handling, checking and inventorying of materials and ease of supervision. Racks should be so located that the handling of materials will be reduced to a minimum and so that there will be no dark pockets for the accumulation of rubbish, etc.

The most general practice is to place the racks transverse to the house, thus permitting natural light from side windows to illuminate the aisles and racks. Some railroads place the racks longitudinal to the house to permit freer observation of the force. On the other hand, this arrangement requires more artificial lighting and more floor space. A one-story house possesses advantages for easy and short trucking but where a very large floor area is required a two- or three-story building is more suitable. Where more than one story is used the upper floors are used for offices (at one end), slow moving and light materials and for an assembling place for work requiring the holding of material until it is assembled for a complete job. Upper floors should be designed for a live load of not less than 250 lb. per square foot. The first floor, if built over a basement, should be designed for a minimum live load of not less than 400 lb. per square foot.

Elevators of at least four tons capacity should be provided. For larger houses one elevator should be provided for each 20,000 sq. ft. of floor area. These elevators should be of sufficient size and capacity to handle an electric truck and trailer. The self-leveling type of automatic elevator with push button control is desirable.

Electric lighting should be provided, with the lamps over the aisles; plug outlets at ends of the racks. The

circuits should be arranged and controlled so that only the lights actually needed would be turned on.

The office should be of sufficient size to accommodate the help, allowing a minimum of 64 sq. ft. for each clerk, together with space for files and separate rooms for the storekeeper and general Foreman. In one-story buildings the office should be at the front end of the storehouse. Where there is a scarcity of floor space available it may be desirable to place the office portion on the second floor. In buildings of two or more stories the office should be at the front end of the second floor.

Metal racks of adjustable units are desirable and should be approximately five feet wide at the base, this section three feet high with an offset of 12 in. on each side and then a top section three feet wide and five to six feet in height. The adjustable units help very materially in making up the proper size of pockets which can be changed from time to time as desired.

Concrete Platforms should be provided along the entire length of storehouses and when motor trucks with trailer trucks are used, a 14-ft. wide platform is recommended. All platforms should have ramps at the ends.

Oil House

The oil house with tracks and switching facilities should be at one end of the storehouse and preferably located at a distance of not less than 50 ft. Oil storage should be in the basement and the first floor used for delivery counter, pumps, oil drums, waste and similar material. For small stores, oil can be stored in a basement under one end of the storehouse with counter pumps, oil drums and waste on the first floor. The oil house portion should be separated from the storehouse by a fire wall.

Oil houses should be built of fireproof materials. Tank of sufficient capacity should be provided in the basement except fuel oil and gasoline, which should be located outside with the tanks underground. Provision should be made to remove any tank in the basement. This opening can be filled with material that can be easily removed. Self-measuring pumps are recommended for handling oil. These should be located on the first floor of the oil house. There are a number of the inclosed pumps that are very economical and efficient on the market. In no case should pitcher pumps or a pump that leaks oil around the pistons or delivery spout be used.

Discussion

[The report was submitted by Chairman F. E. Morrow who moved that the recommendations of the committee on the subjects of general layout of engine terminals; general layout and design of car repair shops, and the ventilation of engine houses be adopted for inclusion in the Manual, and that the report on storehouses for shops and locomotive terminals be accepted as information. The motion was carried without discussion and the committee was dismissed with the thanks of the Association.]

Report of Committee on Ballast

The Committee on Ballast recommended that the design for a 15-tined ballast fork previously submitted be withdrawn. It also recommended that the designs for wood D handles for ballast forks and ballast shovels be eliminated from the Manual and that a note reading "Dee handles of the built-up type may be substituted, if designs, meeting the approval of the ..... Engineers, are submitted."

F. J. Stimson
Chairman

The committee made a study of the specifications for washed gravel ballast and submitted revised specifications which it recommended be accepted as tentative. It collaborated with the Committee on Rules and Organization in revising the rules pertaining to ballast which were presented as information. F. J. Stimson has been on this committee for 20 years and chairman for 3 years.

THE committee presented reports covering the following subjects: 1, revision of manual (Appendix A), 2, revised specifications for washed gravel ballast (Appendix B), 3, proper treatment, from the standpoint of ballast, of track in paved streets or at paved street and highway crossings (Appendix C), and 4, conference with Committee on Rules and Organization (Appendix D).

It recommended: 1, That the changes in the manual as outlined in Appendix A be approved, and the revised version substituted for the present recommendations in the manual. 2, That the specifications for washed gravel ballast be withdrawn from the manual and that the revised specifications as shown in Appendix B be accepted as tentative specifications, it being the intention to submit them for final approval one year hence with such modifications as a year's experience with the consideration of them may develop. 3, That, for the reasons given in Appendix C, the committee be relieved of any further consideration of this subject. 4, That Appendix D be accepted as information, action in regard thereto being in connection with work of Committee on Rules and Organization.

Committee: F. J. Stimson, Chairman (Penna.); G. H. Harris, Vice-Chairman (M. C.); L. L. Adams (L. & N.), G. J. Bell (A. T. & S. F.), J. G. Bloom (C. R. I. & P.), C. J. Coon (N. Y. C.), C. E. Dare (R. F. & P.), F. T. Darrow (C. B. & Q.), J. L. Gonzalez, Paul Hamilton (C. C. C. & St. L.), K. H. Hanger (M.-K.-T.), W. S. Hanley (St. L. & S. W.), A. G. Holt (C. M. & St. P.), G. D. Hughey (D. & H.), H. N. Huntsman (Wabash), S. A. Jordan (B. & O.), G. P. MacLaren (C. N. R.), David McCooe (C. N. R.), M. J. McDonough (D. & H.), M. B. Morgan (Y. & M. V.), R. B.

Robinson (U. P.), W. A. Roderick (W. & L E.), E. I. Rogers (P. & P. U.), C. B. Stanton (Carnegie Inst. of Tech.), Vance Sykes (S. A. L.), C. E. Weaver (C. of Ga.), P. H. Winchester (N. Y. C.), A. H. Woerner (B. & O.).

Appendix A—Revision of Manual

The plan for a 15-tined ballast fork was withdrawn from the manual by the action of the Association at its 1925 Convention. When the Committee on Ballast recommended that action, it was the intention to prepare a new design which would overcome the features pointed out by the manufacturers which made it impossible to produce the 15-tined ballast fork formerly adopted as recommended standard.

It developed in the discussion of this matter that the 15-tined fork was intended for use in removing, in connection with cleaning, stone ballast from the crib between the ties. It is apparent that for such use a tool that will remove all material, dirt as well as ballast, is desirable. The ballast shovel, shown in the manual, is better fitted for such work than a ballast fork, even with the tines as close together as in the discarded plan.

It is recommended that no design for a 15-tined ballast fork be provided for inclusion in the manual.

It is further recommended that the specifications for ballast forks, adopted in 1921, and printed on pages 88-91 in the manual of 1921, and for ballast shovel, adopted in 1923, and printed in the supplement to the manual of 1921, pages 3-7, be revised by eliminating plans printed on pages 6 and 7 of the supplement to the manual of 1921 and further by adding to the plans on pages 91 and 5, respectively, a note reading:

> "Dee handles of the built-up type may be substituted if designs, meeting the approval of the ..... Engineer, are submitted."

Explanation—The scarcity of good handle timber makes the wood "Dee" handle difficult to secure. There have been developed designs in metal as well as split "Dees" which are not only practical and serviceable, but are economical in the use of timber. The revision proposed provides for their use at the option of the purhcaser. The adding of the proposed note to the plan on page 5 makes plans on pages 6 and 7 of the supplement to the manual of 1921 unnecessary.

Appendix B—Revision of Specifications for Washed Gravel Ballast

The existing specifications for washed gravel ballast were adopted at a time when the use of such material was comparatively new. It was recognized by the Committee on Ballast that it was an imperfect specification and with a view to learning the feeling in regard thereto, the sub-committee sent out the following questionnaire to the railroads:

1. Should the amount of sand which is permitted by the specifications be changed?
2. What per cent of gravel should there be between ½ in. and the No. 10 screen?
3. Is it desirable to lower the maximum size from 2½ inches to 2 inches?
4. Should the per cent of large aggregate between the maximum size and one-inch be limited to some particular per cent of the total volume?

Replies were received from 33 railroads using gravel ballast and these indicated a change desired.

It is recognized by the committee that gravel may be well washed, well screened and well graded and yet be practically worthless as ballast because of its lack of resistance to disintegration and wear. Some work has been done looking towards the development of a test for "soundness." As yet nothing has been developed that can be put into practice, but it is hoped that in our next report such a test will be in shape to present for your consideration.

In view of the information developed by the questionnaire referred to above and from other sources, the committee proposed the following:

Gravel for ballast shall be so prepared that all dust, dirt and loam are removed, that all aggregates that will not in every position pass through a 1½ in. ring are either rejected or crushed and returned to the ballast and that the resultant product conform to the following:

Where the percentages of crushed material runs between nothing and 20, the ratios of various sizes of aggregates to the whole shall be as follows:

1/10 in. to ¼ in.	min. 25% max. 40%	½ in. to 1 in.	min. 20% max. 55%
¼ in. to ½ in.	min. 20% max. 30%	1 in. to 1½ in.	min. 0% max. 35%

Where the percentage of crushed material runs more than 20 and less than 40, the ratios of various sizes of aggregates to the whole shall be as follows:

1/10 in. to ¼ in.	min. 10% max. 30%	½ in. to 1 in.	min. 20% max. 60%
¼ in. to ½ in.	min. 20% max. 35%	1 in. to 1½ in.	min. 0% max. 50%

Where the percentage of crushed material is more than 40, the ratios of the various sizes of aggregates to the whole shall be as follows:

¼ in. to ½ in.	min. 20% max. 35%	1 in. to 1½ in.	min. 5% max. 55%
½ in. to 1 in.	min. 25% max. 60%		

A sample of the prepared ballast containing ⅛ cu. ft. shall be placed in a watertight receptacle having a capacity of not less than 1 cu. ft. Into this receptacle shall then be placed two quarts of clear water, after which the receptacle shall be drained off immediately and placed in a glass jar and allowed to settle. If the sediment deposited in the bottom of the jar is more than ½ of 1 per cent of the sample, as determined by weight, the output of the plant shall be rejected until the fault has been corrected.

A sample weighing not less than 150 lbs. shall be placed in or on a screen having round holes 1½ in. in diameter. If a thorough agitation of the screen fails to pass through the screen 98 per cent of the material, as determined by weight, the output of the plant shall be rejected until the fault has been corrected.

One cubic foot of the prepared ballast shall be thoroughly dried, weighed and placed in a screen having ten meshes to the inch and the screen agitated till all particles which will pass have passed through the screen. If the material which passes through the screen exceed 3 per cent of the original sample, as determined by weight, the output shall be rejected until the fault has been corrected.

Inspection—In case inspection develops the fact that the material which has been or is being loaded is not in accordance with these specifications, the inspector shall notify the manufacturer to stop further loading until the fault has been corrected, and to dispose of all defective material that had been loaded in cars, which shall be done at the expense of the contractor.

Measurements—When ballast is being paid for by the ton, and it is impracticable to weigh each car, the weight per yard shall be obtained by weighing at frequent intervals not less than five cars loaded with ballast, the contents of which have been carefully measured. The weight per yard obtained by such a test shall be used in figuring the weight per car until another test is made.

When ballast is paid for by the yard, the amount shall be determined by weighing each car, where practicable, and applying the weight per yard as determined by frequent tests. When impracticable to weigh each car, the contents of each car will be carefully estimated by comparison with cars, the contents of which have been actually measured.

Conclusions

It is recommended that the Specifications for Washed Gravel Ballast now appearing in the Manual be withdrawn and that the revised form prescribed herewith be accepted as a tentative specification with a view to its adoption as recommended practice one year hence.

Appendix C—Proper Treatment, From the Standpoint of Ballast, of Track in Paved Streets or at Paved Street and Highway Crossings

In taking up this question, it was learned that the Committee on Signs, Fences and Crossings, had this

subject under consideration and as it so intimately concerns the work that committee is handling, this committee thought best to leave the subject entirely in their hands.

Appendix D—Special Sub-Committee to Work With the Committee on Rules and Organization

Discussion by correspondence in regard to rules pertaining to ballast was carried on with the Committee on Rules and Organization and the changes were agreed to.

Rule 785—When unloading ballast care must be exercised to secure proper disposition and avoid waste. Cars available best adapted to the work should be used.

Revised Form

Rule 790—The object of ballast is to secure a solid and uniform bearing for the ties, distribute the applied load over a large surface, hold the ties firmly in position, give elasticity to the track and allow the water to pass off freely.

Rule 791—Before distributing ballast the roadbed should be carefully prepared with embankments and cuts widened to conform to standard plan. Track must be kept in good line and surface while ballasting and stakes should be set for this purpose. The ballast program should be so arranged and the supply so regulated as to leave the least possible open track during the progress of the work, with no open track when the season closes. During the progress of the ballasting open track should be watched carefully and protected with the prescribed slow signals.

Rule 792—Where directed by the division engineer, preparatory to the distribution of new ballast, all the old ballast and unsuitable material must be removed to the bottom of the ties for the full width of the roadbed, the old ballast cleaned and the material unsuitable for ballast used for widening embankments or other purposes. At the same time all ties requiring renewal should be replaced and the ties properly spaced.

Rule 793—When the old ballast has been thoroughly cleaned, sufficient new ballast should be unloaded to make the first raise, which is usually made by shovel tamping the ties. Care must be taken in handling ballast to keep it clean and free from earth. Rock or slag ballast must be handled into the track only with ballast forks. When ballasting or surfacing track out of face, both rails must be raised together.

Rule 795—In gravel or broken stone ballast the ties should be tamped solid from 15 in. inside the rail out to the ends. The space under the rail should be tamped well. The center of the tie should not be tamped.

Rule 796—Where the track is electrically bonded, the ballast must be kept at least one inch below the base of rail. At road crossings and platforms where this is not practicable, the rails should be insulated by painting them with an asphaltum or tar product, and good clean stone mixed with the same material should be used for at least one foot each side of the rail.

Discussion

Chairman Stimson presented the report and *moved the adoption of the recommendations for the revision of the Manual in regard to the fifteen-tined ballast fork, and to handles for ballast forks and ballast shovels.*

W. H. Kirkbride (S. P.): I think we should have a standard ballast fork. We have succeeded in getting manufacturers to produce a fourteen-tined fork for the Southern Pacific, with spacing between the tines of approximately half an inch. I think that is what the committee endeavored to get by the original specification. I think we should have a standard fork, not so much for cleaning the ballast out between the ties, but for forking over the ballast to remove the dirt.

Chairman Stimson: I think the last speaker has overlooked the true situation. The specification for a ballast fork that was originally adopted carried two designs, a fourteen-tine fork and a fifteen-tine fork, the fourteen-tine fork being the general conventional ballast fork such as is used by a great many of the railroads. The fifteen-tine fork was designed for the specific purpose of removing ballast from the space between the ties. While having one more tine than the other, its wider overall was less, resulting in a spacing between tines of only three-eighths of an inch. It is that fork that we are proposing to withdraw from the Manual.

Mr. Kirkbride: It is a fact that the manufacturers refused and said they could not manufacture a fork with the tines closer together than half an inch. The ordinary ballast fork that I have seen has tines possibly an inch or an inch and a quarter apart. These are too far apart for ballast. I do believe that we need a fork with tines close together, that will enable us to fork fine material out of ballast when it has become foul with dirt.

The motion was carried.

Chairman Stimson then moved the adoption of the revised specifications for washed gravel as tentative specifications with the addition of a paragraph headed "Uniformity" to read as follows:

"The finished product when loaded in cars must have the various sizes of aggregates uniformly distributed throughout the whole. Any segregation of the aggregate which, in the judgment of the engineer, will lessen the value of the product as ballast, will be cause for rejection."

H. M. Stout (N. P.): The committee has provided in the previous specification, which is continued in this report, a measurement by the ton. I think that that specification or that way of measuring ballast should be discouraged as much as possible. The usual engineering rule for measuring ballast is the cubic yard, and I think it is against the interest of the business to confuse this point by producing or maintaining numerous units.

During the federal valuation of the railroads, all the yardage, probably, was included on the basis of cubic yards, and provisions of the Bureau of Valuation under their Order No. 3, provides that the unit designations, the quantities and descriptions recorded in the completion reports and in the record of property changes shall be stated, so far as possible, in the terms of the inventory taken by this Commission.

Chairman Stimson: I would call attention to the fact that the paragraph on measurements does not limit it to measuring the ballast by the ton. It provides for measuring it by ton if that is the unit of measure under which the ballast is purchased.

It is a matter of record and common practice that ballast is very generally bought by the ton, as that is the easy way to make a ready measurement.

The weights are obtained for transportation purposes and are easily applied in ascertaining the amounts to be covered by the invoices. While I have no question at all in my mind that the yard is the unit which will be used in the records to which reference has been made, I can see no inconsistency in the rule as given here in this specification which, as I have said before, merely recites what everybody knows—how to reduce tons to yards and yards to tons.

C. C. Westfall (I. C.): The concrete engineers have brought out a point in the last few years on the bulking of wet sand which is thrown loosely into a pit. I believe in buying sand it might be well to make a study of that and possibly arrive at the methods of measurements based on price.

Chairman Stimson: The new specification is set up with a view that all sand will be removed, and that the only sand that is tolerated in the specification is

that which has been demonstrated from the operation of pits it is impossible to get rid of in a reasonable commercial way.

The test for the sand requires that the material be dried and that the sand that is found shall be measured in that way, and the limit is set at 3 per cent as being the maximum that will be permitted. I think that any variations that might be due to wetness or dryness of the sand can well be entirely ignored.

President Fairbairn: Mr. Stout, do you have a change to suggest in the two paragraphs under the caption of "Measurements"?

Mr. Stout: I had no change formulated. My thought was to bring the matter before the committee.

[The committee was dismissed with the thanks of the Association.]

Report of the Committee on Water Service

The Committee on Water Service presented a revised list of definitions to replace the present list as published in the Manual. It presented a final report on the relative merits of the different methods of deep well pumping equipment and one on the design, construction and maintenance of pipe lines, both of which will be abstracted and submitted for adoption for inclusion in the Manual at the next annual convention. Progress reports were presented on drinking water supplies; pitting and corrosion of boiler tubes and sheets; the value of water treatment; a comparison of methods of water treatment; and the design of water service buildings. A final report was submitted on boiler washing plants. C. R. Knowles has been chairman of this committee for 3 years and a member for 10 years.

C. R. Knowles
Chairman

THE Committee on Water Service presented reports on the following subjects: 1, Revision of the Manual (Appendix A); 2, Drinking water supply on trains and premises of railways, progress report (Appendix B); 3, Pitting and corrosion of boiler tubes and sheets, progress report (Appendix C); 4, Value of water treatment and comparison of methods, progress report (Appendix D and Appendix E); 5, Relative merits of different methods of deep well pumping, final report (Appendix F); 6, Design, construction and maintenance of pipe lines, final report (Appendix G); 7, Design and construction of water station buildings, final report (Appendix H); and 8, Hot water boiler washing plants, final report (Appendix I).

It recommended: 1, That the revised list of definitions be accepted for publication in the Manual, and that the examination of subject-matter in the Manual be again referred to the committee for further study and report; 2, That the report on the progress of drinking water regulations be received as information and that the subject be reassigned to the committee for further study and report; 3, That the progress report on pitting and corrosion of boiler tubes and sheets be received as information and that the subject be reassigned to the committee for further study and report; 4, That the progress report on the value of water treatment and methods followed in treatment of water be accepted as information and the subject reassigned to the committee for further study and report; 5, That the final report on relative merits of the different methods of deep well pumping be accepted as information. This report will later be abstracted for inclusion in the Manual, and an abstract resubmitted a year hence; 6, That the final report on the design, construction and maintenance of pipe lines be accepted as information. This report will later be abstracted for inclusion in the Manual, and an abstract resubmitted a year hence; 7, That the final report on the design and construction of water station buildings be accepted as information; and 8, That the report upon the use of hot water boiler washing plants effecting water supply be accepted as information.

Committee: C. R. Knowles (I. C.), chairman; R. C. Bardwell (C. & O.), vice-chairman; R. A. Baldwin (C. N. R.), C. M. Bardwell (M.-K.-T.), W. M. Barr (U. P.), S. C. Beach (I. C.), O. W. Carrick (Wabash), R. W. Chorley (Penna.), R. E. Coughlan (C. & N. W.), J. H. Davidson (M.-K.-T.), B. W. DeGeer (G. N.), E. A. Dougherty, (N. Y. C.), J. M. Fitzgerald (C. of Ga.), C. H. Fox (C. P. R.), E. M. Grime (N. P.), J. P. Hanley (I. C.), J. R. Hickox (C. B. & Q.), C. P. Hoover (City of Columbus, O.), C. D. Johnson (D. & R. G.), J. H. Knowles (S. P.), C. H. Koyl (C. M. & St. P.), P. M. LaBach (C. R. I. & P.), E. G. Lane (B. & O.), A. R. Pierce (Sou.), O. T. Rees (A. T. & S. F.), H. H. Richardson (M. P.), T. D. Sedwick (C. R. I. & P.), D. A. Steel (Ry. Age.), C. P. VanGundy (B. & O.), H. W. Van Hovenberg (St. L. S. W.), F. J. Walter (N. C. & St. L.), F. D. Yeaton (C. M. & St. P.).

Appendix A—Revision of the Manual

The Committee presented a large number of revised and supplemental definitions of terms used in railway water service to be substituted for definitions now in the 1921 Manual, and supplements thereto.

Appendix B—Report on Regulations of Federal and State Authorities Pertaining to Drinking Water Supplies and Sanitary Examination of Drinking Water Supplies

Reference was made in our last report to new drinking water standards recommended by an advisory committee appointed by the Surgeon-General of the United States Public Health Service and composed of representatives from the government, scientific societies and sanitarians. The recommendations were made solely for the regulation of railroad drinking water, and it is to be noted that the advisory committee had but one railroad member.

The new standards for railroad drinking water were adopted by the Treasury Department and are now in force, printed copies being obtainable in Public Health

Report dated April 10, 1925. These new standards are more rigid in general trend and in some respects constitute an improvement over the former standards. The notable differences are (a) the added importance of the survey; (b) the dependence placed upon the presence of gas-forming bacilli in laboratory tests with relegation of gross bacterial count as non-essential, and (c) the defining of a standard sample as consisting of five 10 c.c. tubes. The following quotation, as showing more breadth of judgment of the water under consideration, is here given: "Supplies which on rigid inspection are found satisfactory in other respects but fail to meet the bacteriological standards may be accepted at the discretion of the certifying authority." The survey of water source, protection, pumping and delivery to the public is stressed and the scope of this survey gone into in detail, it being considered as fundamental and of the utmost importance. These two points, namely, the presence and percentage of gas-forming bacilli and the added importance of the field survey constitute the basis for acceptance or rejection of the water under consideration.

The chemical and physical characteristics are considered to be of secondary importance, it being judged that if taste, color and odor are acceptable and the water supply satisfactory from the standpoint of safety as determined from the field survey and laboratory tests, it will usually be found satisfactory with respect to physical and chemical characteristics.

It is to be noted that the new standards are for the guidance of the state and federal authorities in recommending or rejecting the water supply, and the report makes clear that a supply will be considered acceptable if certified by the United States Public Health Service, even if it fails to conform to the new standards on bacteriological, chemical or physical characteristics.

Two supreme court decisions from Pennsylvania and Wisconsin, respectively, have been handed down on the matter of stream pollution with industrial wastes or other pollution, both being against the right of persons or corporations to contaminate the waters of the stream and thereby place in danger the lives of persons living thereon.

Appendix C—Pitting and Corrosion of Boiler Tubes and Sheets

The development in the study of pitting and corrosion during the past year has not added much information to the reports and conclusions which have already been presented to the association by your committee, particularly the able summary which was prepared for the last convention under the direction of Dr. M. E. McDonnell.

The developments to date tend to confirm the theory of corrosion, based on electro-chemical reactions, which was outlined by this committee in the preliminary report made in 1922. This is based on the fact that iron is soluble in water to only a very limited extent, forming a ferrous hydroxide. To increase this reaction to the point where practical evidence of pitting is noticed, it is necessary for oxidation to take place and remove that soluble iron so that more can be taken into solution. This oxidation is a chemical term, meaning not only the possible addition of oxygen, but any other reaction which might increase the valency, or power, of combination of the iron and change the balance or equilibrium of the solution. The features affecting this action may be briefly outlined as follows:

(1) **Hydrogen-ion Concentration**—At the Baltimore meeting of the American Chemical Society in April, 1925, a symposium on "Corrosion" was held at which many papers were presented, giving the results of a large amount of experimental work which has been done on the theory of corrosion. Although the discussion included many points in the wide range of this subject, the general conclusion on sub-aqueous corrosion appeared to be that the phenomena was a straight-line function of the hydrogen-ion concentration, and the effect of contributory elements is minimized by increase in temperature. The hydrogen-ionization is essentially, and in substance, the relative acidity of the solution, which is increased by the concentration of common alkali salts, such as sodium sulphate or chloride, in a manner not determinable by the ordinary volumetric tests. The remedy for cases of this trouble appears to be maintaining an excess of hydrate alkalinity in the boiler water. This covers not only the increase in relative acidity caused by increase in alkali salts, but also the cases of direct mineral acidity, including carbon dioxide, such as surface waters occasionally encounter in coal districts polluted by mine drainage.

(2) **Carbon Dioxide**—The importance and effect of free carbon dioxide inside of locomotive boilers, has not been definitely established. By maintaining the proper relation of hydrogen-ion concentration as outlined above, any possible damage from this feature can be eliminated.

(3) **Oxygen**—The effect of dissolved oxygen is well known in the stationary boiler field and its elimination has produced successful results at many points. However, in locomotive practice, there is considerable question as to whether such conditions are comparable, as the variable rate of evaporation, together with violent surging, produces conditions which tend to minimize such effects.

(4) **Alloys and Coatings**—Experiments to date, with alloys and coatings, have not indicated that a commercially adaptable and practical product is available which can be used successfully in boiler construction.

(5) **Influence of Suspended Matter, Including Mud and Scale**—Instances have developed where pitting and corrosion have taken place under scale, particularly of the calcium sulphate variety around the base of staybolts. Cases of this kind can be readily eliminated by proper addition of soda ash or maintaining a caustic hydrate alkalinity in the boiler.

(6) **Counter-Electrical Method**—Experiments with the counter-electrical potential method of preventing corrosions are still under way.

(7) **Design and Construction of Boilers**—The study of the effect of design and construction of boilers is a subject which more logically comes under societies other than the American Railway Engineering Association. However, it has been noted that, in the design of the larger locomotives which are now being placed in railroad service, some trouble is experienced where the large crownsheets and side sheets are not properly stayed, and also the expansion and contraction of the long flues, in some cases, may cause movement in the flue sheets which may result in a change in the crystalline structure of the metal with consequent difference in potential and resultant pitting. Some examples have been noted of serious ring pits around staybolts which can be accounted for either by the sheets not being properly matched, or the cold punching of staybolt holes, either case causing re-

arrangement of crystallization with resulting difference in potential and pitting of the sheets.

(8) **Kind and Care of Material**—The committee is not in a position to question the A.R.A. specifications for materials used in boiler construction and it is felt that the study which has been given to this subject by other committees has been sufficiently thorough to warrant the best results if the specifications are followed. This can only be obtained if the specifications are rigidly adhered to, as the use of non-homogeneous material is known to result in pitting. The care of the material is a feature which is also being given better attention. It is known that when pitting has once started, the action is frequently continuous until failure results, due to the difference in potential and electrolytic action which is set up. Atmospheric corrosion, or rusting, is most common and where boiler material is used on which corrosion has already started, pitting and ultimate failure is most probable. This can be largely prevented by proper storing of materials or coating with rust-proof compounds, several of which are on the market and commercially available.

Appendix D—Cost of Impurities in Locomotive Feedwater and Value of Water Treatment

The committee reviewed its report of last year wherein it reduced the data as to economies resulting from water treatment to savings per locomotives per year, and made new computations in which the results were equated by taking into account the amount of work performed by the locomotives on the divisions which were being compared, for the different years under consideration. Figures were presented showing results for the Sioux City and Dakota Division and the Iowa Division of the Chicago, Milwaukee & St. Paul, and for the St. Louis division and the Iowa division of the Illinois Central. For brevity, detailed tables were given ony for the Iowa division of the Chicago, Milwaukee & St. Paul, and summaries for the other divisions.

The total amount of scale kept out of the boilers by the water treatment was also computed and attention was again called to the fact that the esimate made by the committee in 1914 of 7 cents per pound of scale kept out, now estimated at 13 cents because of higher prices, is below the actual savings.

Appendix E—Comparison of Different Methods of Water Treatment

Lime-Soda Treatment

The oldest and at the same time the standard and usual method of water softening for locomotives, and most large boiler installations, is by chemical precipitation and settling before the water goes to the boiler. The object of the process is both to precipitate from solution the calcium and magnesium salts and remove the precipitated sludge, so as to deliver boiler water which is not only soft but clean. While this method continues to be known as the "Lime-Soda Process" because of the common use of these reagents, it will not be forgotten that the equipment is complete for the use of any reagents or any variation of method which the character of the water may demand.

There is nothing in the chemical treatment or cleaning of water which cannot be accomplished in one of these plants. Any water can be so treated in them that in a boiler it will cause neither scale nor leaking, and will not cause foaming in a locomotive until the sludge and alkali salts become highly concentrated.

Soda-Ash Treatment

For many years this addition of soda ash has been made to the water in the engine tank, and the results are good when the amount necessary is small and when the engine crew attend to it faithfully as the water is received from the roadside tank. But the boiler will soon commence to foam unless regularly and consistently blown out; and because the crew is more interested in getting over the road than in saving fuel or boiler repairs, it has been found difficult to get soda ash added regularly by this method.

The best and most economical method of utilizing soda ash in boilers consists in adding exact quantities to the water as it is being pumped into the roadside tanks. Because the treatment is exact there is no waste of chemical, and practically no hard scale forms in the boiler. The total amount of sludge deposited in the boiler depends on the hardness of the water, and the total amount of alkali salts in the boiler is the sum of the alkali originally in the water and the soda ash added.

Proprietary Boiler Compounds

There are also proprietary mixtures of soda ash and vegetable extracts which are dissolved in the water in the engine tank and used to keep the boiler scale somewhat soft so that it can be more easily washed out. It is claimed for the vegetable extract that it has a colloidal effect on the particles of calcium carbonate and sulphate precipitated by the heat, so that these particles do not attach themselves to the heated metal surfaces but remain loose sludge suspended in the water in the boiler. The influence of colloids on both hot and cold suspensions is now under intensive study and agreement has not yet been reached; but experience shows that these boiler compounds do keep boilers reasonably clean when used on waters of low hardness. Next to soda ash these are the cheapest boiler cleaners for simple waters, and, like soda ash, they are better when fed into the roadside tanks in proportion to the character and amount of water pumped.

Zeolite Treatment

Zeolite is the name commonly given to a class of minerals which are double silicates of aluminum or iron with sodium or potassium, and some of which have the remarkable property of giving up their sodium or potassium to hard water poured over them, and taking in exchange the calcium or magnesium from the water. The value of this material for water softening lies in the fact that the process is reversible, and that a solution of sodium chloride (common salt) poured over this changed mineral will take away its calcium and magnesium, replacing it with sodium and restoring the mineral to its original condition.

Summary

The method of softening by barium hydrate or barium carbonate and lime, leaves certain waters soft and clean, and does not increase the content of sodium salts.

The method of softening by soda ash and lime leaves any water soft and clean, and increases the sodium sulphate by the amount of original sulphate hardness.

The method of softening by zeolite leaves water soft and clean, but increased in sodium salts by the total original hardness, and for locomotive boilers the method can utilize only the simpler natural waters.

The method of treatment by soda ash applied to water in roadside tanks, leaves water which still con-

tains carbonate of lime and magnesia which precipitates as sludge in the boiler; and the method is satisfactorily applicable only to the simpler waters.

The method of treatment by soda ash or any boiler compound applied to water in the engine tank, is always a palliative but is sufficient only in the simple waters.

In the matters of foaming and priming in boilers, the experience of members of this committee and other authenticated records vary over such wide limits that it is not considered safe to make more than a general statement. It is known that the foaming limit of any boiler is affected by the kind and the amount of sludge, the concentration of alkali salts, the steam space in the boiler and the ratio of the rate of dry evaporation to the rate of steam consumption. The committee has made measurements of these relations on a few waters and boilers and kinds of sludge, and is continuing its investigation in the hope of learning something of general value.

Appendix F—The Relative Merits of the Different Methods of Deep-Well Pumping

One of the common methods of obtaining suitable water supply for railroad requirements is by means of drilled or artesian deep wells. On account of the depth to reach deep-well supplies and the limited space available for pump installation and operation, special deep-well pumping equipment must be installed. In general, the most common types of such pumping equipment are the deep-well reciprocating pump, the deep-well centrifugal or turbine pump and the air lift. For complete and detailed information of description and principles of the various types on the market, reference should be made to latest manufacturer's bulletins.

In considering the relative merits of the different methods of deep-well pumping, consideration should be given to the following features: character of the water; capacity of source of water supply; pumpage required; pumping head; first cost of complete installation of equipment; length of useful life; reliability; flexibility; efficiency, and cost of operation.

At locations where the water to be pumped from deep wells contains an appreciable amount of sand or gritty materials, the air lift pump will give the best and the reciprocating pump the poorest service. The air lift having no working parts is not affected to any large extent by such materials in the water.

Where the yield of a well is relatively small and strata are moderately deep, the reciprocating pump is most desirable. The turbine pumps are primarily large capacity pumps and are not suitable for low yields. If a single well will not furnish the pumpage required, and if wells are widely separated, the air lift is conveniently used at each well by piping compressed air from a central compressor station. For a given diameter well, the air lift will produce the largest yield.

The reciprocating pumps are made to fit in well casings from 5-in. diameter up to 30 in. diameter and are capable of yields from 20 gal. to 2,500 gal. per minute. The turbine type pumps are made to fit in well casings from 6-in. diameter up to 24 in. diameter which yields ranging from 100 to 5000 gal. per minute. The air lift pumps are made to fit in well casings from 3 in. to 18 in. diameter with yields from 15 to 3,300 gal. per minute.

In general, the first cost of the turbine-type pump is highest and first cost of air-lift pump including compressor but not prime mover is lowest. The direct connected motor driven turbine pump, however, requires less housing than either of the other two types.

As to reliability and length of useful life, the type and fitness of the pump for the service required are large determining factors. The air lift pump with no working parts below the ground is probably the most reliable, although the compressor unit may give occasional trouble. The centrifugal or turbine- type pump has fewer working parts to get out of order than the reciprocating pump. The high speed of turbine-pump shafting, however, demands careful alignment of shaft and attention to bearings. All three types of pumps are flexible to a certain extent. The reciprocating pump is the most flexible over a medium range of pumping yields with the least variation in pumping efficiency. The turbine type is most suitable for constant conditions of head and yields. The air-lift pump is flexible over a great range of heads and yields although the efficiency is altered considerably.

In general, efficiencies of the reciprocating pumps will reach 80 per cent under most favorable conditions, turbine pumps 65 per cent, and air lift pumps 35 per cent. On account of its low efficiency the air-lift pump is seldom used except under specific conditions which would make the other types of pumps unsuitable.

Under average conditions maintenance costs of the air lift systems will be lowest and reciprocating systems highest. Attendance costs are relatively the same. Each of the three systems can be operated automatically, if desired. As the pumping economy depends very largely on suitable pump and power equipment for given conditions, after choice of pump and equipment has been made and pump installed, tests should be run at convenient intervals to develop what changes, if any, have occurred in operating condtions. A record of all inclusive costs of pumping should be kept for ready reference and comparison.

Each type of deep-well pumping equipment has its respective advantages and disadvantages over other types. To insure reliability and greatest over all economy, individual conditions should be thoroughly considered and analyzed before choice of equipment and purchase from reputable manufacturer is made.

Appendix G—The Design, Construction and Maintenance of Pipe Lines

The intake line may be classed as a flow line, as it conveys water by gravity from the source of supply to the well. It operates under a low head and its cross-sectional area should be sufficient to convey the required quantity of water at a velocity not exceeding two feet per second, as an excessive velocity creates currents near the exposed end of the pipe and these currents convey floating debris into the well.

In placing intake lines in rivers it is advisable to turn the pipe slightly down stream or to place a bend on the river end of it to decrease the likelihood of floating debris lodging in the pipe by the force of the river current. In rivers or other waters containing floating debris, some railways use a box screen or a cone-shaped screen having an area three to four times greater than the pipe area. Where the debris is of such character that it may adhere to a screen, provision should be made for raising or otherwise cleaning this screen.

It is preferable to lay the intake line in a level position, and this grade should be true and uniform, as sags or traps in the line may collect deposits of sand or muck and allow same to build up to the bottom of the true flow line, thereby decreasing the working area of the pipe. A gate valve should be placed on the well

end of the intake pipe with a valve rod extension above high water, for closing the intake line when necessary to clean the screens or foot valves which may be located in the well.

While almost any kind of pipe manufactured may be used for intake lines, the use of bell and spigot cast-iron pipe with joints of lead or composition or the use of wrought iron pipe with standard joints, is preferable, as such pipe is very durable and heavy enough to resist current and wave action to good advantage.

The design of intake pipes is usually simple for the average railway pumping station, as these intake lines seldom exceed 100 ft. in length. The diameter of intakes under these conditions should be 12 to 14 in. for a flow of 500 to 1,000 gal. per minute, as these sizes are sufficient to convey these water flows without objectionable currents, even after allowing for incrustations and deposits which may form in the pipe lines.

Where the water is shallow, the pipe may be installed by sectional trenching or light cofferdam work. Where the water is deep and the length to be laid considerable, the use of floating barges, derricks and other equipment is usually economical or necessary. The joints in the cast-iron intake lines should be constructed of lead, lead wool, or composition in the usual manner of pouring and calking. The design should, wherever possible, provide for these joints being made above the water line or in a water-free trench or cofferdam, as the making of the joints can then be checked more thoroughly than if they are installed under water by a diver.

Intake lines constructed of sound material and in accordance with good design require little maintenance, except where it is necessary to clean sand, ice or debris from them. When this is necessary the conditions requiring attention should be made as accessible and as easily handled as possible.

In some cases it has been found satisfactory to back wash intakes and intake pipe lines with water piped from the pumping station. In this case a head of water is accumulated in the intake well by closing the gate valve on the intake line, then opening the valve quickly and flushing and jetting the material backward to the outlet. In other cases the use of a small dredging bucket with a capacity of two to three cubic feet, operated either by hand or power methods has been found very useful in baling the accumulated material from the intake.

Suction Lines—Design—A suction line is a line through which a pump draws its supply. The suction line may enter the source of supply direct or it may obtain water from an intake well. For reservoirs, or lakes and rivers where there is little wave action and a small amount of floating debris it is satisfactory to have the suction pipe enter the supply direct, but in bodies of water having severe wave action, considerable amounts of floating debris, or as a method of frost protection, the intake well is recommended.

Suction lines should be as short as possible and of such size or cross-sectional area that when the pipe line friction is added to the static suction lift the total of both will be easily within the suction lift capacity of the pump and if possible should not exceed 15 ft.

In centrifugal pump installations it is necessary to install either a foot valve or a check valve on the bottom end of the suction line, but in reciprocating pump installations these valves are not usually necessary, except where the suction lift is excessive. Where such valves or where a screen is installed, arrangements should be made for removing the debris which will usually accumulate on them.

In making the connection between the suction pipe and the pump where the pipe is necessarily one or two sizes larger than the suction opening on the pump, the connection should be made by a reducing elbow or an eccentric tapered reducer with the straight side up or in some other manner that will prevent a depression in the top of the flow line at this point and thus prevent the collection of air in the upper portion of the suction pipe.

Suction Lines

Genuine wrought iron pipe with screwed joints is the best pipe for suction lines. Flanged wrought iron, flanged cast-iron and bell and spigot cast-iron pipe may be used, but there is less danger of small air leaks in the screwed wrought iron pipe joint than any of the other joints, especially where the pipe is subjected to vibration or settlement after installation. The objection to the use of wrought iron pipe is that it is less durable than cast-iron, but this can be largely overcome by painting the exterior of the pipe with a coating of hot pitch and tar and wrapping with burlap after the manner of gas pipe services where the soil conditions warrant this treatment.

All horizontal sections of suction lines should be laid with a slight grade (about 3 in. per 100 ft.) toward the source of supply. This grade should be true and uniform and the earth rammed underneath the pipe to prevent local settlements after backfilling, as sags in the line will allow air to collect and thus impair the efficiency of the suction line and pump.

If suction lines are laid of screwed wrought iron pipe on a true grade there will be little maintenance on them. If bell and spigot cast-iron pipe is used, there may be some maintenance required in calking leaks. Most of the maintenance will occur on the foot valves in cleaning debris from same and in applying new valve leathers.

Discharge Lines

As this is the pipe through which water is forced by the pump, it is not necessary to lay it at as true a grade as is desirable in intake and suction lines, but it may follow the grade of the land. However, it is best to lay the pipe on as straight a line and on as easy a grade as cost conditions permit and to eliminate as many bends and fittings as possible. Each 12 ft. length of cast-iron pipe can be offset not to exceed 4 in. from a straight line without impairing the joint, and this method should be used where slight changes of line or grade are required in the pipe line instead of using fittings. The pipe line should be laid close to the right-of-way line so as to clear as far as possible all future track and building construction.

At the point where the pipe connects to the pump a swing check valve and gate valve should be installed and another gate valve placed near the roadside tank or discharge end of the pipe. If the pipe line is laid in hilly or rolling country, air valves to relieve air-binding should be installed at the summits and blowoff valves to discharge sediment located in the valleys. These valves should be inspected, maintained and operated on a regular schedule and not neglected. The use of gate valves in the discharge line at one-half mile intervals or other suitable locations is advisable if sectional control of the line is desired.

If discharge lines are laid of the proper class and grade of pipe with good joints and protected from vibration and water hammer, there will be very little maintenance on them, as the material itself is durable and depreciates slowly. The maintenance expense will

be greatest in repairing leaks which usually occur under tracks, and it is advisable to protect pipe lines by a conduit when such lines pass under switches or tracks which make repairs frequent and expensive. This conduit may be composed of concrete or cast-iron culvert pipe through which the water line is laid, or may be composed of timber or masonry. The conduit should be of such design and of sufficient size and inside clearance to permit the calking of leaks, which may occur even under the best conditions.

Where favorable conditions exist, it is often found desirable and economical to secure a satisfactory water supply by gravity from an impounding reservoir at a sufficient elevation above the point of use. In all such cases care must be exercised in locating and laying the pipe line to see that no portion of it lies above the hydraulic gradient. If any portion of the pipe line lies above the hydraulic gradient, the pressure at this point will be less than atmospheric, with the consequence that air may accumulate in the line and affect the quantity of water delivered and may even result in a complete stoppage of the flow.

The design, construction and maintenance of service line is similar to discharge lines. Cast-iron service pipe in sizes 1½ in., 2 in. and 3 in. is being placed on the market. This pipe is made with screwed, calked and flexible bolted joints, and the use of this pipe for service lines of these sizes will give a cheaper and more durable installation than wrought steel or wrought iron standard screwed pipe, especially where the soil contains pitting or corrosive elements.

Pipe Coatings and Linings

The standard specifications for cast iron pipe and special castings of the American Water Works Association specify that cast-iron pipe shall be coated inside and out with coal tar pitch varnish, in which the pipes and castings shall be immersed at a temperature of 300 deg. F. This coating is satisfactory except in regions having corrosive water. For waters of this kind cement-lined pipe is beginning to be used in municipal water service.

Conclusions

(1) We consider cast-iron pipe to be generally preferable to other classes of material for pipe lines except suction lines.

(2) We consider genuine wrought iron pipe with screwed joints generally preferable for suction lines.

(3) We recommend the use of air valves on summits and blowoff valves in the valleys, for discharge and service lines laid through a rolling country.

(4) We recommend the encasing of important water mains in larger pipes or conduits where such mains are laid in congested railway yards or at locations where it is impossible to space the pipe joints clear to of the tracks. This conduit should be of such design and have sufficient clearance to allow calking of possible leaks in the main.

(5) We recommend that cast-iron pipe be given consideration for service lines in sizes 1½ in. to 3 in., which sizes are now usually laid with screwed wrought steel or wrought iron pipe.

(6) We recommend the specification of the American Water Works Association for the manufacture of cast-iron pipe and special castings.

(7) We recommend piping water from the pumping station to the intake for flushing it or the use of a small dredging bucket operated by hand or power methods for baling debris from it, as good methods for keeping intakes cleaned.

On account of the extent of the subject, the variations in local conditions, financial ability of the roads, and personal ideas of the engineer, the committee tried to make the report expressive of sound practice rather than complete detail. Members of the Association interested in more detail are referred to a list of 22 articles dealing with pipe lines, which have appeared in various issues of *Railway Engineering and Maintenance.*

Appendix H—Design and Construction of Water Station Buildings

In this report the committee outlined called attention to the importance of housing mechanical pumping equipment in substantial buildings to avoid the risk of interruption to service. Attention was called to the conditions that should govern the design of buildings for different types of pumping equipment, as well as for pumpers' cottages, for places where it is necessary to provide living quarters for the pumpers.

Appendix I—Boiler Washing Plants as Affecting Water Supply

The committee called attention to the economies to be effected by blowing out locomotives into hot water pumps and using the hot water for washing boilers, this method resulting in savings in time, water, coal and boiler repairs. The committee's conclusions and recommendations were as follows:

(1) Storage tanks should be of sufficient capacity to take care of the maximum number of boiler washouts without waste of water or heat.

(2) Lattice work cooling devices may be provided for the blowoff tank to cool the water as much as possible by exposure to the atmosphere instead of cooling it by adding fresh water. Fresh water should be used only for makeup purpose.

(3) A sludge collecting system might be installed in the tank bottom for discharging accumulated sludge. This will avoid emptying tank of water and taking it out of service.

(4) Blowoff water not needed for washout purposes may be utilized at the cinder pit and for other purposes for which the water is suitable.

Discussion

[The report was submitted by Chairman C. R. Knowles, who moved that the recommendations as to revision of the Manual be accepted by the Association.]

R. A. Tanner (N. P.) (after calling attention to the wording and substance of certain of the definitions): As I have pointed out several corrections, and as others may be offered, I recommend that Appendix A be presented as informations at the convention. The adoption into the Manual may well be postponed a year without serious inconvenience, and will afford the committee opportunity and time to put Manual matters into first class shape.

Chairman Knowles: We are not permitted to discuss definitions on the floor of the convention, so I cannot go into details. It would probably be sufficient to say that some of these suggestions of Mr. Tanners have been referred to the Committee, and they will be given consideration.

The Committee recognizes some of the objections are well taken, but some of the definitions referred to are now in the Manual. Others are additions, but they will be considered in due order.

The motion was carried.

[The reports on the subjects in the remaining ap-

pendices were presented, with the motion that they be accepted as information.]

Maurice Coburn (Penna.): I think we are very much to be congratulated on having had all this information collected as to the value of the treatment. We hope now that he will be able to go ahead and differentiate between the different kinds of impurities and tell us something about that, because it makes a great deal of difference whether you have sulphate scale or carbonate scale as to the damage which the water is going to do. It is a subject of which a good many of our operating officers do not appreciate the value.

In the summary of methods of treatment, I should like to ask what the committee means by speaking of the simpler waters in connection with the method of treatment by soda ash.

C. H. Koyl (C. M. & St. P.): The word "simpler" was perhaps not used advisedly. We intended to mean waters that were not very hard, a few grains per gallon of carbonate calcium magnesium, a few grains per gallon of sulphate calcium magnesium; it did not mean simple in the technical sense of the word, but that they were waters easy to treat.

Mr. Coburn: Some of us on our road think that the difference between the soda ash treatment and the lime of soda ash treatment, or the difference in the value, is overestimated and that the amount of foaming and priming due to sludge is very much overestimated.

Chairman Knowles: I will say for Mr. Coburn's information, we have a great deal of work yet to do before we make a final report on this subject, and we hope to complete the work in such a manner that it will be satisfactory to everybody and cover all the points that have been raised.

[The reports were accepted as information and the committee was excused with the thanks of the Association.]

Report on Records and Accounts

The Committee on Records and Accounts presented a progress report on methods and forms for gathering and recording data for keeping up to date the physical and valuation records of railway property. A report was submitted on the feasibility of reducing the number of forms in the maintenance of way and engineering departments, with the request that it be relieved of further consideration of the subject. It cited the savings to be made but suggested, in view of the great variety of organizations on the railways, that the work can best be accomplished by form committees on the individual roads. It also presented a progress report on the comparison of daily and monthly time and material reports. H. M. Stout, chairman of the committee for the last 6 years, has been a member of it for 12 years.

H. M. Stout
Chairman

THE committee presented reports covering the following assigned subjects: (2) Methods and forms for gathering and recording data for keeping up to date the physical and valuation records of the property of railways.

The first progress report on this subject was presented to the Association last year and the second progress report was presented in Appendix A. It is expected that the final report will be submitted next year.

(3) Feasibility of reducing the number of forms used in the engineering and maintenance of way department, combining forms and simplifying those retained (Appendix B.).

(6) Comparison of daily and monthly time and material reports.

The first progress report on this subject was presented last year and the second progress report was submitted this year (Appendix C). It is expected that in the final report recommendations of the forms and the specifications and directions for their use will be presented for publication in the Mannual.

It recommended: 1, That the report on subject No. 2, Physical and Valuation Records of Railways, given in Appendix A, be received as a progress report. 2, That the report on subject No. 3, given in Appendix B, be received as a final report and the subject discontinued. 3, That the report on subject No. 6, given in Appendix C, be received as a progress report.

Committee: H. M. Stout, (N. P.) chairman; V. R. Walling, (C. A. W. I.), vice-chairman; E. G. Allen (A. T. & S. F.), W. J. Kelly (C. R. I. & P.), A. M. Blanchard, (C. N. R.), Henry Lehn (N. Y. C.), L. H. Bond (I. C.), J. R. Leighty, (Sou.), Z. M. Briggs (Penna.), H. T. Livingston (C. R. I. & P.), A. C. Copland (C. & O.), E. W. Metcalf (M. K.-T.). E. B. Crane (C. M. & St. P.), R. E. Patterson (L. V.), H. C. Crowell (Penna.), H. J. Sargent (Wabash), C. C. Haire (I. C.), H. F. Sharpley (C. of Ga.), H. E. Hale (P. C. C.), C. K. Smith (U. P.), J. H. Hande (B. & O.), H. M. Tremaine (N. P.), W. A. Hill (C. B. & Q.), W. A. VanHook (Ford, Bucon & Davis), F. W. Hillman (C. E. N. W.), G. R. Walsh (M. P.), T. J. Irving (C. E. N. W.), H. R. Westcott (N. Y., N. H. & H.).

Appendix A—Methods and Forms for Gathering and Recording Data for Keeping up to Date the Physical and Valuation Records of the Property of Railways.

The sub-committee presented a second progress report on this subject.

The subjects upon which the sub-committee submitted a report this year were as follows:

1. Definitions of Terms.
2. Organization for Collecting, Compiling, Recording and Filing.
3. Forms for Recording Changes in Physical Property.
   (d) Record of Side Tracks.
   (e) Structural Record—Buildings.
   (f) Roadway Machine Record.

(g) Shop Machine Record.
(h) Equipment Index—Record of Equipment Index Changes.

5. Mandatory Forms Required by Federal Regulations.
(c) Record of Property Changes.

In recommending an organization for collecting, compiling, recording and filing, consideration was given to the carriers' own requirements and to the regulations of the Interstate Commerce Commission's Valuation Order No. 3 and the regulations of various states.

The collecting, compiling and recording and filing of data for keeping up to date the physical and valuation records is so closely allied to the railway's accounting methods that it is considered in the interest of efficiency and economy that all the requirements can well be combined.

For years many carriers maintained some form of organization which recorded currently and reported to the Interstate Commerce Commission annual expenditures to Investment in Road and Equipment, and requirements of some few states necessitated reports from a few carriers as to changes in physical property, so that many railroads had some scheme to collect and record information for all accounting purposes and for their own internal needs.

The issuance of Valuation Order No. 3 has brought to the front the need of greater refinement and elaboration of accounting for Investment in Road and Equipment expenditures, as it is mandatory to set up property changes in detail on prescribed form and to submit summaries of the result, annually and semi-annually.

The procurement of information as to physical changes to the property of railways naturally requires an orderly and systematic method of procedure. The mandatory requirements outlined briefly certain procedure, but it is insufficient to meet all the needs of the carriers for their physical records and accounting work.

The methods considered best by the sub-committee for gathering and recording data can be summarized as follows:

(1) All physical changes to property to be included in an annual budget, excepting special and emergency cases, which it may be necessary to handle, or the condition of expenditures and revenue may permit of subsequent changes to the budget, which can be added thereto.

(2) All changes in physical property, except ordinary repairs, to be carried out under an "Authority for Expenditure."

(3) "Authority for Expenditure" estimates should be prepared in the same general form as required to record the expenditures on roadway completion reports, so that a direct comparison can be made and so that the estimates may serve as a guide to those who handle construction accounting.

(4) Expenditures to be recorded, tentatively distributed and summarized under the direction of the organization responsible for collecting, compiling, recording and filing physical data, and the system of records and accounts required for investment in Road and Equipment and other mandatory regulations of states and the Interstate Commerce Commission.

(5) Physical changes to be inventoried and recorded by proper units under the direction of the organization mentioned immediately above.

(6) The analysis of charges and comparison of inventory of physical property, perpetuated to compile final accounting records and records of physical changes required for carriers' internal use and mandatory regulations to be handled under the direction of the organization mentioned above.

The record of physical changes to property is needed in the operation and maintenance of the carriers and it is important to keep up to date maps and profiles and to have complete records of this nature to show what changes were made. In the administration and handling of an engineering department, correct station maps, profiles, right-of-way and alinement maps and records, etc., are of importance and these records must be maintained to a high state of perfection at all times.

The keeping up to date of the valuation records of railroad property, aside from the physical records, involves the question of amounts added to and retired from the investment account of the carriers and as such amounts are based upon construction costs and information originating with engineers and their subordinates, the sub-committee is of the opinion that construction cost accounting is a joint accounting and engineering function, for the following reasons:

(1) The accounting and engineering work involved in handling the collecting, compiling, recording and filing of data for the physical changes to property, as is required for carriers' own use and in the mandatory form, and the accounting for Investment in Road and Equipment projects, are inseparable.

(2) The handling of accounting in connection with construction cost and the engineering work in connection with collecting, compiling, recording and filing the physical changes to property, requires specialized employees of both engineering and accounting experience.

(3) The control of capital expenditures and those expenditures chargeable to operating expenses or other accounts, in connection with construction work, is a responsibility of the engineers who are in charge of the execution of work and the inseparable engineering and accounting work required, for construction expenditures must be coordinated with such control of expenditures.

In considering the mandatory requirements of the various regulatory bodies, both federal and state, and the carriers' own needs, it is obvious that it is both efficiency and economy to organize so as to satisfy all the following purposes simultaneously:

(1) Collect, compile, record and file data for carriers' own use, such as:
(a) Construction cost data and physical records.
(b) Investment in plant for tax return purposes.
(c) Investment in plant for insurance schedule purposes.
(d) Participation in joint ownership.
(e) Investment in joint facilities.
(f) Compile indices of price trends for equaling original cost to date, to cost of reproduction for rate purposes.

(2) Accounting for Investment in Road and Equipment expenditures.

(3) Records and accounts prescribed by Valuation Order No. 3 and Supplements No. 1 and No. 2 thereto.

(4) To comply with the requirements of Valuation Order No. 23, which requires the maintaining up to date of certain valuation maps.

(5) To comply with state laws and requirements of public service commissions.

To comply with governmental regulations it is necessary to carry out the suggestions made in the preceding paragraph. It is necessary, further, that the data be compiled concurrently with the progress of the work; therefore the carriers' own interests will also be served by making the reports within the time limits prescribed by the legal requirements.

The sub-committee's recommendations for a separate bureau or department form of organization for collecting, compiling, recording and filing department data are based upon the following conclusions:

(1) The collecting, recording, compiling and filing data and keeping up to date the physical and valuation records of the property of railways is essentially the responsibility of both accounting and engineering organizations, and,

(2) Some one individual should be made responsible for the handling of the mandatory regulations of the federal and state commissions and for collecting and compiling physical data, as well as to handle all accounting features.

(3) Accounting features should be inclusive of accounting for Investment in Road and Equipment.

(4) That with such departmental or bureau organization all requirements to state commissions, federal commissions, tax bodies, etc., can be combined and one set of records and accounts used for all purposes.

(5) That the proper control of capital expenditures and construction costs is essential to scientific management, and this can be best effected by a joint bureau or departmental form of organization, removed from influences or prejudices of any other department's own needs.

Under the subject of Forms for Recording Changes in Physical Property the sub-committee presented a form for record of sidetracks which it recommended be substituted for Form 1106 now in the manual. It also presented forms for buildings, roadway machines, shop machines, and for an equipment index.

Mandatory Forms Required by Federal Regulation

The "Record of Property Changes," generally spoken of as Exhibit "E" of Valuation Order No. 3, Second Revised Issue, is a record that was originally designed for the dual purpose of recording and consolidating units of a like kind that are added and deducted periodically from the property of the carrier, and, also, to record and accumulate expenditures by debits and credits periodically. The record is primarily to perpetuate the federal valuation by units and by money.

As a record of expenditures it differs from the usual railway accounting procedure in recording the investment charges currently, in that Exhibit "E" requires a record of final or total expenditures only when the project is in transportation service, whereas the accounting method is to report chronologically the debits and credits as they originate from any source.

There is a growing thought in connection with this record, which is tending towards the abolition of the method of showing units and it may be that in the future the only record that will be required will be one to record only gross charges and gross credits, by valuation sections, by primary investment accounts.

The sub-committee, in its investigation of the entire subject, is of the opinion that this record serves no useful purpose to carriers and that as years go by the immense volume of the record will be such as to prelude any possible use. It has been found that those carriers who have attempted to use the record, after a lapse of some years from the date they were valued, found it necessary to seek recourse in the basic record, the Roadway Completion Report, in order to bring the valuation down to date on any basis.

So long as carriers are required to maintain a "Record of Property Changes," the sub-committee recommends two methods as follows:

Roadway Changes

(1) Exhibit 21 has been designed for the use of the larger carriers and it permits of recording the units added and the units retired with the attendant costs of such units. It is similar to the mandatory form in Valuation Order No. 3, Second Revised Issue, except that several additional columns have been provided so as to allocate the cost to units added and retired.

(2) For the smaller carriers, Exhibits 22 and 23 have been designed for recording property changes. Exhibit 22 requires a separate sheet for each unit; accordingly there will be a number of sheets for each primary account.

The record is to be maintained separately by valuation sections and is of some advantage over Exhibit 21 as it permits of accumulating the expenditures, year after year, for any group of units, particularly by individual structures.

Each year the gross charges and gross credits recorded on Exhibit 22 should be summarized on Exhibit 23 for the purpose of preparing the annual returns to the investment account as required by Valuation Order No. 3, Second Revised Issue, on B. V. Form No. 589.

Equipment Changes

The subject of recording equipment changes has been covered under Subject No. 3, "Forms for Recording Changes in Physical Property," (h) "Equipment Index—Record of Property Changes," and the recommendations are that the method outlined should be followed, in lieu of using the same "Record of Property Changes" as for roadway work.

Appendix B.—The Feasibility of Reducing the Number of Forms in the Maintenance of Way and Engineering Department, Combining Forms and Simplifying Those Retained.

The committee made a study of this subject and while it recognized the economies to be made by reducing and simplifying forms, it felt that it could not submit proposed standard forms, owing to the variety of organizations on the different carriers. It suggested that the work might best be performed by committees on individual carriers. As a supplement to its report the committee presented a paper prepared by E. B. Stewart, chairman of the Forms Standardizing Committee of the Southern Pacific, describing the work of that committee, which resulted in discontinuing 44 per cent of forms of all departments on that system.

For the reason outlined, the committee recommended that the subject be discontinued.

Appendix C.—Comparison of Daily and Monthly Time and Material Reports.

In its report to the 1925 convention the committee presented its arguments for the use of daily time reports, and developed a form for such a report which it considered as fulfilling all of the essential requirements. In making its presentation, the committee stated that the assigned subject "could be considered sufficiently broad to permit of an examination of all reports concerning maintenance of labor and material." The committee further stated that "In addition to the basic forms for use of the foreman in reporting time and material consumed, forms should be provided for assembling this information promptly and economically; that is, in a manner that will give the greatest benefit to the maintenance engineer, consistent with the cost of assembling it. These consolidating or condensing forms will be the subject of subsequent reports."

In continuing the study under this assignment, there remains, therefore, the development of a daily material report and the outlining of a procedure, and forms for condensing and classifying the data that would be collected on these daily labor and material report forms. In carrying out this work, two objectives must be kept constantly in mind: First, that the design of each step in the routine be made with a clear conception of the requirement of the maintenance engineer, and second, that the clerical operations above those made mandatory by the Interstate Commerce Commission accounting instructions be kept to a minimum.

The statistics which it is considered essential that the maintenance engineer be furnished were outlined in the report of the sub-committee on "Cost-Keeping Methods, Statistical Records and Forms for Analyzing Expenditures for Assistance in Controlling Expenditures" for 1925. The two conclusions enunciated in that report may well be repeated here. They are (Italics Ours):

"1. The Classification of Operating Expenses as prescribed by the Interstate Commerce Commission, is not formulated to show directly unit costs of any item of maintenance of ways and structures, *but these data may be compiled to show unit cost of maintenance per equated track mile or similar unit.*

"2. Unit costs of the main items of maintenance, particularly those pertaining to roadway and track, may be determined by subdivision of the primary accounts in such manner that the charges are allocated to those items. *This sub-division of primary accounts involves some additional expense, which is well justified when the information thus obtained is used in determining and comparing unit costs, and is recommended as good practice.*"

The committee presented forms which it believed fulfills the essential requirements and also a chart showing the steps by which unit costs of doing work are developed from the foreman's daily reports.

The system designed for gathering these data should be aimed, therefore, at obtaining:

(1) Cost of maintenance per equated track mile or similar unit.

(2) Unit costs of main items of maintenance by sub-divisions of primary accounts.

The sub-committee's conclusions were as follows:

(1) The cost of the few additional clerical operations shown herein, over and above the cost of those made mandatory by the commission's accounting instructions, is small in comparison with the benefits to be obtained from the resulting unit cost data.

(2) The statistical control of maintenance expenditures is desirable and is possible through cooperation of the accounting and maintenance engineering organizations in establishing a simple chain of reporting operations.

(3) As the maintenance engineer receives the most benefit, the burden of urging the adoption of a comprehensive reporting system falls upon him and his organization. Persistent effort is necessary to overcome the inertia of the established accounting systems.

The lighter the grade, the better.—As a general proposition, the lighter the ruling grade, the better, or, stated in another way, the ideal grade is level, provided traffic is the same in each direction. It is noted, however, that in actual operation the question of drainage sometimes becomes important in long cuts on very light grades. This, however, is an element of cost of construction and should be taken care of by increasing the grades of the roadbed ditches or by the use of tile drains, as may be most expedient.

Primary advantage of the lighter gradients.—Heavily-loaded cars, such as are usually loaded with coal and ore, will ordinarily develop a frictional resistance of about 4 lb. per ton. Grade resistances for 0.4 per cent, 0.3 per cent and 0.2 per cent grades are, respectively, 8, 6 and 4 lb. per ton. Consequently, neglecting engine resistances (which are higher per ton, but which are relatively small in gross amount for very long trains on low grades) the total train resistances per ton for heavy tonnage trains on grades of 0.4 per cent and under may be stated approximately as follows:

0.4 per cent	12 lb. per ton
0.3 per cent	10 lb. per ton
0.2 per cent	8 lb. per ton

It is evident, therefore, that the primary advantage of the lighter grades in the weights of trains which can be handled, as compared with a 0.4 per cent grade, is for a 0.3 per cent grade 20 per cent increase, and for a 0.2 per cent grade 50 per cent increase. This primary advantage will usually be offset to some extent by the increased time required to haul the heavier trains. But in most cases it would appear more economical to utilize this advantage as far as practicable by the elimination of unnecessary stops for the heavy trains.

Uniform Speed.—With the lighter grades there will be less variation in the rate of grade and consequently less variation in the speed, a condition which tends to economy in maintenance of road as well as of equipment.

Starting Resistance.—It would appear that starting resistance rarely limits the tonnage of trains on light gradients, inasmuch as the locomotive starts one car at a time and there is a great deal of slack in long trains handled on very light grades. However, it is undoubtedly good practice to lighten the grades at necessary stops, say 0.1 per cent, wherever practicable, and limit the number of necessary stops. The use of a booster will tend to reduce any disadvantage as to starting resistance and time lost for stops.

Length of Grade.—Experience has shown heretofore that ruling grades of excessive length have required reduction in the weight of trains. In certain cases the use of a lighter gradient may require longer maximum grades, but in other cases this result will not necessarily follow, as the adoption of lighter gradients will require the finding of lower summits, the use of tunnels instead of open cuts, or the adoption of a line which from its topography produces less rise and fall.

Discussion

(Vice-President Brumley took the chair and the report was submitted by Chairman H. M. Stout, as information.)

C. C. Cook (B. & O.): It seems to me that we have come to the parting of the ways as to the use of sub-accounts in maintenance of way expenditures, since 1914, at least. The sub-accounts have been in the classification of operating expenses. I think it is very accurate to say that not five per cent of the railroads have used those sub-accounts. If they are not of any value, it seems to me that when the revision of the classification comes out, this Association would be in poor position to say they would like to continue those sub-accounts. I think they would have to agree with the accounting officers that they ought to be removed. Here for the first time the Association goes on record as suggesting that practical use be made of them to determine unit cost. I think that the railroads have been criticized, maintenance of way departments have been criticized because they have not known their unit cost by which they can make comparisons as between different railroads or as between different divisions of a railroad or a subdivision of a railroad. It would not be unfair to compare the cost of applying new rail per ton on one division with the cost of applying new rail per ton on another division, even though the average weight of rail applied was not exactly the same.

There are so many other elements that enter into the cost of applying rail that more largely affect it than does the difference in weight of rail, that the figure that you would derive would be valuable in any event.

I think the attention of the railroads should be drawn to these forms and some effort should be made to get the data from the accounting department according to these sub-accounts, and the statistics brought before this convention. That would be a way that this committee could follow up their suggestion.

Maurice Coburn, (Penna.): It is my understanding that on the Pennsylvania we are trying to put in these forms that Mr. Stout has mentioned.

Chairman Stout: Do you know whether the time return book that was presented last year was included in that set?

H. C. Crowell, (Penna.): It was included.

J. H. Hande (B. & O.): The B. & O. has used forms of this character and even in more detail than is shown here, and is getting excellent practical results in comparing the figures from the various divisions and broadcasting to the division engineers coparative results. I can't go any further than that as to practical results, but the forms are in use daily.

Vice-President Brumley: The report of this committee has been submitted as information. The work is to be continued during the ensuing year. If there is no further discussion I wish to say that this committee has undertaken a very difficult task. Their work involves not only engineering, but the accounting of railroads and sometimes I think must border upon the legal phases of railroad operation. The committee is to be complimented

on the excellent work it has done in presenting this progress report to this annual convention.

The committee was dismissed with the thanks of the Association.

American Railway Engineering Association Registration

THE registration of members and guests of the American Railway Engineering Association yesterday totaled 690, including 554 members and 122 guests. This compares with a total of 663 on the opening day last year, 541 of whom were members and 122 guests.

Abbott, R. B., asst. gen. supt., Reading Co., Reading, Pa.
Adams, Lem, rdwy asst., pres.'s staff, U. P. Omaha, Neb.
Alexander, F. W., dist. engr., C. P., Vancouver, B. C., Canada.
Allen, L. B., engr. main. of way, C. & O., Richmond, Va.
Ambrose, J. R. W., ch. engr., T. T., Toronto, Ont., Canada.
Amory, G. G., engr., C. & W. I., Chicago.
Anderson, B. T., supt. of sig., C. & O., Richmond, Va.
Anderson, Irving, div. engr., A. T. & S. F., Marceline, Mo.
Angerer, Victor, v. p., William Wharton, Jr., & Co., Easton, Pa.
Anthony, F. D., D. & W., West Chicago, Ill.
Armour, Robert, con. masonry engr., C. N., Toronto, Ont., Canada.
Armstrong, C. E., asst. engr., N. & W. Ry., Portsmouth, O.
Armstrong, J. E., asst. engr., C. P., Montreal, Canada.
Arn, W. G., asst. ch. engr., Chi. Term. Impts., I. C., Chicago.
Arthur, G. F., asst. engr., I. C., Chicago.
Atwill, A. L., asst. engr., C. & W. Ind., Chicago.
Austill, H., bridge engr., M. & O., St. Louis Mo.
Backus, M. M., asst. engr., main of way, I. C., Chicago.
Badger, O. C., engr., Railways Bureau, Portland Cement Association, Chicago.
Baldridge, C. W., asst. engr., A. T. & S. E., Chicago.
Balkwill, Stephen, pres., The Balkwill Manganese Crossing Co., Cleveland, O.
Ballantyne, T. B., div. engr., C. P., Farnham, Quebec, Canada.
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Balliet, H. S., engr. of train con., N. Y. C. Lines, New York City.
Baluss, F. C., engr. bridges and bldgs., D. M. & N., Duluth, Minn.
Banks, T. E., asst. gen. mgr. treating plant, Long Bell Lumber Co., Shreveport, La.
Bardwell, C. M., asst. water engr., M.-K.-T., Waco, Tex.
Bardwell, R. C., supt. water sup., C. & O., Richmond, Va.
Barnhart, E. H., ind. engr., B. & O., Baltimore, Md.
Barrett, W. C., trainmaster, Lehigh Valley, Sayre, Pa.
Barry, G. R., supt., P. R. R. System, Richmond, Ind.
Batchelder, F. L., ch. engr., C. R., Houghton, Mich.
Batchellor, F. D., div. engr., B. & O., Garrett. Ind.
Bates, F. E., bridge engr., M. P., St. Louis, Mo.
Beach, D. P., div. engr., Penna. Indianapolis, Ind.
Beach, Dr. S. C., health of., I. C., Chicago.
Beal, F. L., design. engr., St. L. S., Tyler, Tex.
Beal, F. D., timber preserving engr., Chicago.
Beard, M. H., asst. div. engr., B. & O., Akron, O.
Beckett, F. T., engr. main. of way, C. R. I. & P., El Reno, Okla.
Belcher, R. S., mgr. treat. plants, A. T. & S. F., Topeka, Kan.
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Hinman, Dean, engr. bldgs., C. G. W., Chicago.
Hirschthal, Meyer, concrete engr., D. L. & W., Hoboken, N. J.
Hobbs, W. H., engr of design, M. P., St. Louis, Mo.
Hockman, H. M., first asst. engr., N. Y. C. & St. L., Frankfort, Ind.
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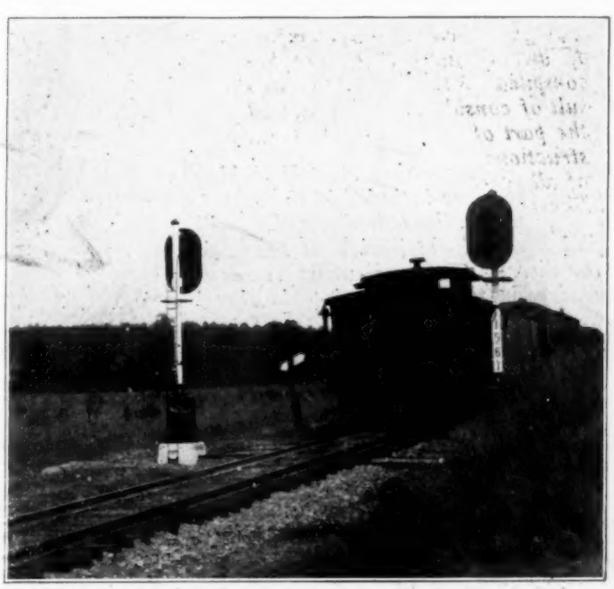
Hurst, C. M., Hurst Automatic Switch & Signal Co., St. Louis, Mo.
Johnson, R. K., supvr. sigs. & water, C. & O., Peru, Ind.
Johnson, S. C., chf. chem., C. & O., Huntington, W. Va.
Jones, L. A., asst. supvr. track, B. & A., Worcester, Mass.
Kempton, W. H., Chicago.
Kerner, L. L., B. & O., Akron, Ohio.
Kittles, E. G., asst. engr., Southern, Charlotte, N. C.
Knapp, J. W., Jr., C. & O., Richmond, Va.
Koehler, P. L., asst. cost engr., C. & O., Huntington, W. Va.
Laughton, H. H., asst. to vice-pres., Southern, Washington, D. C.
Legro, H. W., asst. div. engr., B. & M., Peabody, Mass.
Lindsay, J. H., asst. div. engr., B. & O., Connellsville, Pa.
Lindstrom, R. S., architect, Chicago.
Marshall, H. S., Ohio Valley Rock Asphalt Co., Louisville, Ky.
Marshall, R. G., Chicago.
McCabe, E. M., supvr. b. & b., B. & A., Pittsfield, Mass.
McDaniel, W. L., Massey Concrete Products Corp., Cincinnati, Ohio.
McDonald, F. T., Chicago.
McDonald, J. H., vice-pres., Steelton & Highspire, Steelton, Pa.
McMullin, H. L., chem., M. P., Little Rock, Ark.
Moorman, J. S., asst. trainmaster, L. H. & St. L., Louisville, Ky.
Morgan, S. H., rdmaster, A. R., Knoxville, Tenn.
Muller, G. W., pres., Muller Railway Track Systems, Washington, D. C.
Nall, V. C., St. L. S. W., Tyler, Tex.
Nelson, H. W., pres., H. W. Nelson Co., Chicago.
Ormsbrey, J. E., Joseph E. Nelson & Sons, Chicago.
Orton, F. E., asst. engr., A. C. L., Rocky Mount, N. C.
Painte, J. F., supvr. track, C. & O., Clifton Forge, Va.
Peck, O. K., br. engr., D. & R. G. W., Denver, Colo.,
Pembroke, W. C., asst. div. engr., B. & O., Grafton, W. Va.
Popejoy, C. F., M. P., Atchison, Kan.
Poshusta, D. C., Long-Bell Lumber Co., Shreveport, La.
Powers, J. T., asst. to group engr., Presidents' Conference Committee, New York City.
Price, J. W., supvr. water sup., C. & O., Ashland, Ky.
Rapp, G. W., chf. engr., Ohio Valley Rock Asphalt Co., Louisville, Ky.
Reeve, C. S., The Barrett Co., New York City.
Rush, D. B., Robert W. Hunt Co., Chicago.
Russell, J. A., engr. water co.'s, Penna., Philadelphia, Pa.
Sadohara, I., engr., Japanese Government Railways, Tokyo, Japan.
Schauble, F., supr. track, B. & A., Pittsfield, Mass.
Schmucker, L., asst. engr. on corps., B. & O., Akron, Ohio.
Shuck, R. E., asst. dist. engr., N. P., Livingston, Mont.
Simpson, W. E., sanitary insp., C. R. I. & P., Little Rock, Ark.
Smith, E. L., supvr. track, Penna., Millersburgh, Pa.
Smith, S. M., asst. bridge engr., Wabash, St. Louis, Mo.
Stang, Thomas, b. & b. supvr., N. P., Jamestown, N. D.
Stevens, F. R., prin. asst. engr., Rutland, Rutland, Vt.
Stevens, A. E., C. P., Winnipeg, Man.
Stimmel, R. M., chem., C. & O., Huntington, W. Va.
Tajima, T., civil engr., Japanese Government Railways, Tokyo, Japan.
Tanner, R. A., C. & O., Barboursville, W. Va.
Tebbett, J. C., water engr., B. & O., Baltimore, Md.
Teichart, E. G., rdmaster, Virginian, Duquesne, Pa.
Teller, C. B., rdmaster, C. R. I. & P., Kansas City, Mo.
Tiedt, J. E., supvr. water treatment, C. R. I. & P., El Reno, Okla.
Towson, W. O., asst. engr., B. & O., Baltimore, Md.
Upson, A. T., National Lumber Manufacturers' Association, Washington, D. C.
Wahlman, J. H., asst. supvr., B. & A., Boston, Mass.
Wearn, J. S., asst. engr., Southern, Knoxville, Tenn.
Weedon, R. E., supt. rdway shops, Southern, Washington, D. C.
Wellman, R. L., supvr. b. & b., C. & O., Huntington, W. Va.
Wesley, J. B., chem., M. P., Kansas City, Mo.
White, U. F., supvr., Penna., Salisbury, Md.
Wilsey, G. H., chf. engr., St. Paul Union Depot Co., St. Paul, Minn.
Zeeman, M. J., asst. engr., A. T. & S. F., Chicago.

Western Society of Engineers Discusses I. C. Electrification

Many engineers who are attending the convention took advantage of the opportunity last evening to attend the regular monthly meeting of the Western Society of Engineers which was devoted to "The Electrification of the Illinois Central Suburban Service in Chicago." The society rooms were packed with many having to stand throughout the meeting while the speaker, W. M. Vandersluis, electrical engineer, Chicago Terminal Improvements, Illinois Central, gave a general description of the problem of electrifying this road in the Chicago area and the contract arrangement for the purchase of power. The details also included descriptions of the track layout; overhead power distribution and negative return systems; sub-station connections, switching, and tie systems. A brief description of the cars and method of operation were also included.



New A.C. Color-Light Signals on Seaboard Air Line

Typical Change-Over from Lower-quadrant Semaphores to Color-light Signals on the Burlington

Second Day of Signal Meeting

Six committee reports, one paper and the election of officers feature closing day's program

THE closing session of the Signal section convention at the Drake hotel yesterday was opened by Chairman W. M. Post at 10 a. m. During the day action was taken on the six remaining reports. The outstanding report of the day was that of Committee V—Instructions, on which there was an extensive discussion as to whether the hand book should be completed and published for the benefit of signal maintainers. Various chapters of this book are being prepared by different committees and the chapter on direct current relays was approved for publication. Among the other committees reporting were those on Power Interlocking, D. C. Automatic Signals, Designs, and Chemicals. After an extensive discussion the report on chemicals was returned to the committee as being undesirable for approval in the Manual. Included in the report of Committee VIII—A. C. Automatic Signals, was an extensive paper on the subject of "Lightning Protection for Low-Voltage Circuits", by E. Beck, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

The results of the annual election of officers were announced and the new officers were conducted into office. The next annual stated meeting will be held on September 7, 8 and 9, at the Ambassador Hotel, Los Angeles, Calif.

Report of Committee V—Instructions

A great deal of useful information of an instructional nature has been compiled by this committee as the result of considerable time and effort on the part of the members. Detailed instructions for testing electric locking of all types are included in the report. These instructions undoubtedly will find a useful application as the basis for directions to be issued by various roads for the benefit of their signal inspection forces. Similar application can be made of the instructions presented with reference to inspecting mechanical locking. An outline of the chapters for a proposed handbook on signaling and the text and illustrations for a chapter were presented. J. S. Gensheimer, chief signal inspector, Central region, Pennsylvania Railroad, Pittsburgh, Pa., was appointed chairman in November, 1923.

J. S. Gensheimer
Chairman

THE committee submitted reports on instructions for testing electric locking; instructions for inspecting and testing mechanical locking of an interlocking machine; instructions for inspecting d.c. relays; hand book on signaling, chapter VI—direct current relays, and definitions for technical terms used in signaling.

The committee recommended that the instructions for testing electric locking and for testing and inspecting mechanical locking be accepted for submission to

letter ballot. It was requested that a discussion be given on chapter VI of the hand book and the instructions for inspecting relay in shops. Revised definitions for technical terms under the headings A to C, inclusive, were submitted for submission to letter ballot to supercede material now in the manual.

Instructions For Testing Electric Locking

Electric approach locking. 1. Approach locking must be tested at least quarterly as follows:

(a) When lock is on signal lever. To insure that the lever or latch cannot be restored to the normal position, with the proper route set, signal cleared where necessary, and approach circuit open, each contact in the approach circuit must be opened separately (multiple circuits to be open) and attempt made to restore the lever or latch to normal position.

(b) When combined with switch lever locking. To insure that the levers or latches cannot be moved from the normal or reversed position after the signal has been cleared and approached circuit open, signal lever must be restored to normal position, each contact in the approach circuit opened separately (multiple circuits to be open) and attempt made to move the lever or latch from normal or reversed position.

(c) Multiple circuits must be tested by opening each contact cut around in the approach circuit with the multiple circuit closed and, when lock is on signal lever, restore the lever latch to normal position; when combined with switch lever locking, move the lever or latch from normal or reversed position. This test must be made separately for each multiple circuit .

(d) Time interval must be checked and time releases kept within 10 per cent of the time designated. The time for which the release is set must be marked on each release.

Electric time locking. 11. Time locking must be tested at least quarterly as follows:

(a) When lock is on signal lever. To insure that the lever or latch cannot be restored to the normal position, until the designated time interval has elapsed, lever must be reversed and an attempt made to restore the lever or latch to normal position while the time release is operating.

(b) When combined with switch lever locking. To insure that the levers or latches cannot be moved from normal or reversed position, until time interval has elapsed, attempt must be made to move the lever or latch from normal or reversed position while the time release is operating.

(c) Multiple circuits must be tested as outlined in Instruction 1-c.

(d) Time releases must be inspected and checked as outlined in Instruction 1-d.

Electric indication locking. 21. Indication locking must be tested:

(a) On signal levers at least quarterly. To insure that the levers or latches cannot be placed in the normal position.

1. For a semaphore signals, until the corresponding home signals are within 5 deg. of the stop position and distant signals are within 5 deg. of the approach position, signal must be cleared and the lever then restored to indicating position and, holding signal arm by hand, let signal arm gradually resume the normal position, during which time the person operating lever should be endeavoring to restore lever or latch to normal position.

2. For light signals, until the corresponding home signals are in the stop position and distant signals are in the approach position, signal must be cleared and the lever then restored to indicating position, keeping signal control relay picked up, endeavor to restore lever or latch to normal position.

(b) The operation outlined in Instruction 21-a to be repeated for each signal arm controlled by such lever.

(c) On switch or lock levers at least monthly. 1. When operated, locked and indicated by the same lever. To insure that the lever and switch or switches or other operated units are in the corresponding position and switches locked before lever stroke can be completed and mechanical locking released, lever must be operated to indicating position and each switch or other unit separately prevented from completing stroke, then attempt to complete stroke of lever or latch.

2. When locked and indicated by lock lever. To insure that the operating lever and switch or switches or other operated units are in corresponding position before lock lever can be operated and mechanical locking released, switch or switches or other units must be operated and each switch or other unit separately prevented from completing stroke, then attempt to unlatch the lock lever.

Electric switch lever locking. 31. Switch lever locking must be tested at least weekly as follows:

(a) To insure that the lock will hold the lever or latch, locking circuit must be opened and lever or latch moved against the lock several times while no train is occupying or approaching the section of track affected.

(b) To insure that a lock will not release while the circuit is occupied, each lever must be unlatched or floor push operated (but the lever must not be moved) while a train is on the circuit and the lock observed closely to see if it releases. When practicable, this test should be made while light engines are passing over the crossovers.

32. **Switch lever locking must be tested as follows:** (a) At least monthly. Each track circuit must be shunted at several points with a wire, giving particular attention to crossovers and turnouts and noting that each track and repeating relay opens.

(b) At least quarterly. Each route should be set and the proper relays operated to determine that the route locking is effective.

W. M. Post
Chairman

The election of Mr. Post to the chairmanship of the Signal section last March following a long period of service in active committee work, is a mark of recognition well merited. His railway experience, while largely of a signal nature, includes also several years in the operating department. Nearly 30 years ago he entered the signal department construction forces of the New York, New Haven & Hartford, leaving that road in 1905 to join the Pennsylvania. The following year he was appointed assistant supervisor of signals. In January, 1917, he became assistant signal engineer, Eastern lines, and a year later filled a position in the operating department as assistant superintendent. Effective June 1, 1925, he was promoted to assistant chief signal engineer of the Pennsylvania system.

Electric traffic locking. 41. Traffic locking must be tested at least monthly as follows: (a) To insure that the lock will hold the lever or device for changing the direction of traffic, locking circuit must be opened and the lever or latch moved against the lock several times while no train is occupying or approaching the section of track affected.

(b) To insure that a lock will not release while the section of track protected is occupied, each lever or device for changing the direction of traffic should be tried repeatedly (but not operated sufficiently to permit changing direction of traffic) while a train is running over that section and the lock closely observed to see if it releases. When practicable, this test should be made with a light engine.

For Inspecting and Testing Mechanical Locking of an Interlocking Machine

Inspection. 1. The various parts of the locking bed, locking bed supports and connections must be inspected to see that they are properly secured.

2. Driving pieces, dogs, stops and trunnions must be inspected to see that they are properly secured to the locking bars.

3. Locking bars in new locking must have full stroke as follows:

(a) Mechanical interlocking machine, Improved S. & F. locking ..... 1¾ in.
(b) Mechanical interlocking machine, Style A locking ..... 7/16 in.
(c) Electro-mechanical interlocking machine, Improved S. & F. locking.
  1. Lever with full stroke having S. & F. driver ..... 1¾ in.
  2. Lever normally center having rack driver ..... 2⅝ in.
(d) Electro-mechanical interlocking machine, Improved S. & F. miniature locking ..... 1 in.
(e) Electro-mechanical interlocking machine (Style A miniature locking).
  Vertical locking ..... ¼ in.
  Horizontal locking ..... 11/32 in.
(f) Power interlocking machine, Improved S. & F. miniature locking ..... 1 in.
(g) Power interlocking machine (Style A miniature locking.)
  Vertical locking ..... ¼ in.
  Horizontal locking ..... 11/32 in.
(h) Table interlocking machines.
  1. General ..... 1½ in.
  2. Union ..... 1 in.

4. Splices in longitudinal locking bars must be inspected to see that they are straight and properly made.

5. Where new locking is to be placed in service or a change in locking is made, the locking must be compared with the dog chart to see that they agree.

Testing. 11. Locking must be tested before interlocking on machine is placed in service, when a change in locking is made, and at least annually as outlined in Instructions 12, 13, 14 and 16.

12. When a lever or latch which should be locked can be moved more than shown below, it shall be considered as having too much lost motion and lost motion must be removed.*

(a) Mechanical machine.
  1. Latch operated locking. When lever latch block can be raised to within 3/16 in. of the top of the quadrant.
  2. Lever operated locking. When a lever latch block can be moved more than 3/16 in. on top of a quadrant.
(b) Electro-mechanical machine.
  1. Lever moving in horizontal plane. When a lever can be moved more than 1/8 in. when in the normal position or 3/16 in. when in the reversed position.
  2. Lever moving in an arc. When a lever can be moved more than 3 deg.
(c) Power machine.
  1. Latch operated locking. When a lever latch block can be raised to within 7/32 in. of the top of a quadrant.
  2. Lever moving in horizontal plane. When a lever can be moved more than 1/8 in. when in normal position or 3/16 in. when in the reversed position.
  3. Lever moving in an arc. When a lever can be moved more than 3 deg.

13. On electro-mechanical interlocking machines, the locking between the electric and its mechanical levers must be tested to insure that mechanical levers cannot be operated except when properly released by the electric levers.

14. Latch shoes, rocker links and quadrants of S. & F. machines must be inspected and tested for lost motion that would permit locking to release if the foot is used on the rocker while a lever is in midstroke position.

15. Where new locking is to be placed in service or a change in locking is made, a complete test must be made of the locking from the locking sheet by placing all levers normal, when practicable, then testing levers consecutively, commencing with lever with lowest number to see that each lever locks all other levers in the position required by the locking sheet.

16. Complete test of the locking from a signal layout or interlocking plan must be made as follows:

(a) Test locking between switch, derail and movable frog levers.
(b) Test locking between facing point lock and switch, derail and movable frog levers.
(c) Set up each route and endeavor to release latch or operate each signal lever that should be locked by that route; then raise the latch on signal lever, or reverse signal lever, governing movements over route, endeavor to release latch or operate each lever that should be locked by the signal lever; then restore latch or lever to normal position and make similar test with the lever or latch for the opposing signal.
(d) Where route or traffic levers are used, make test as outlined for signal levers in Instruction 16-c.

17. When new locking is to be placed in service or a change in locking is made, to insure that locking of a route does not interfere with parallel routes, the parallel routes must be set up and signal levers operated for movements in both directions on each route.

*These requirements are for interlocking machines in service. For new machines there should be practically no lost motion in locking or connections.

Hand Book on Signaling

The committee submitted a report on this subject at the 1925 stated meeting, in which it outlined the chapters for the proposed hand book on signaling.

Chapters I to V, inclusive, have not been completed. Considerable work has been done on Chapter I—Historical and on Chapter V—Batteries. Committee X has agreed to prepare Chapter III—Principles of Signaling, and Committee I has agreed to prepare Chapter IV—Economic Phase of Signaling. The committee presented with this report, for discussion, Chapter VI—Direct Current Relays. Some work has been done on Chapter VII—Direct Current Track Circuits. Chapter VIII—Transformers, has not been started. Chapter XI—Alternating Current Relays, is nearly completed. The Special Committee on Highway Crossing Protection is to prepare Chapter XXII—Highway Crossing Protection, and Committee X will prepare Chapter XXV—Train Control. No work has been undertaken on the other chapters.

(Instructions for Inspecting and Testing D.C. Relays in Shops, which was submitted for discussion only, are omitted here.—Editor).

Committee—J. S. Gensheimer (Penna), chairman; C. M. Duffy (C. R. I. & P.), vice-chairman; A. Vallee (D. & H.), vice-chairman; H. E. Arnold (L. V.), W. A. Bartley (I. R. T.), H. L. Black (C. N.), E. E. Bradley (W. M.), B. F. Dickinson (Penna.), C. E. Earhart (A. & V.), Oscar Falkenstein (O. C.), H. J. Foale (Wab.), C. J. Goodwin (N. Y. C.), A. J. Kelly (C. C. C. & St. L.), Forrest D. Morehart (S. A. L.), F. A. Selke (C. I. & L.), W. H. Stilwell (L. & N.), C. A. Taylor (C. & O.), G. K. Thomas (A. T. & S. F.), and L. F. Vieillard (L. I.).

Discussion

J. S. Gensheimer (Penna.), Chairman: The Signal section, instructions for testing electric locking, were presented at the stated meeting and have been slightly revised to conform to some of the suggestions made. I move that the instruction as revised be accepted for submission to letter ballot. *Motion carried.*

Mr. Gensheimer: The instructions for inspecting and testing mechanical locking of an interlocking machine were presented at the 1924 stated meeting. No comments have been received and they are submitted for acceptanc for submission to letter ballot, and I so move. *Motion carried.*

Mr. Gensheimer: The committee has been working on several chapters of the hand book. After preparing the chapter on d. c. relays it was discussed with a sub-committee of Committee IV. The committee is anxious to get the views of members on this book.

Chairman Post: This is an important venture for the Signal section to make. The mere printing of hand books will involve quite a large expense. I think both the committee preparing the hand books and the Committee of Direction would appreciate the views as to whether or not such hand books are worth while.

J. W. Kunker (B. & O.): I don't believe there is any subject that this body of men has ever attempted to handle that will be of greater benefit to the railroads through the developing of real signal men than this educational program. I believe that many supervisors will read a book of this kind and derive benefit from it.

F. W. Pfleging (U. P.): I have on my desk two inquiries, one from the University of Missouri, and one from an Oklahoma school, asking where they can obtain signal information. They had men in the field last summer on various installations of signals on the Missouri Pacific and the Santa Fe, and these men coming back to school want some information. If we can put out some standard practice, I think this is the association to do it. If we do not, some one else will, and we will follow along an educational program of some one outside of the association.

E. T. Ambach (B. & O.): It is noted that historical facts are used which will lead the student up to the point of present-day practices, and I think the committee would do well to keep up that same theory, that we have progressed a great deal in the last 15 or 20 years.

R. D. Ellsworth (N. Y. C.): The important officers have a Manual and the proceedings, but we have had very little that could go and be understood by the rank and file. As signaling grows, more men will become engaged in it, and there is greater need for something along the line of this proposed hand book that the average maintainer or beginner can use, and I think the association can well afford to incur the expense of printing this hand book.

Mr. Pfleging: Did you want a motion whether the association should print the hand book or not?

Chairman Post: I think possibly it would be better to leave it to the Committee on Direction to decide whether this book will be published. It is quite probable that these books will be printed as pamphlets and not as one large book.

Mr. Gensheimer: Our definitions for technical terms were presented at the stated meeing in 1924.

Mr. Gensheimer: *I move that these definitions be accepted for submission to letter ballot superceding submatter now in the Manual. Motion carried.*

[The committee was then excused with the thanks of the Association.]

The Aim of Technical Education

By E. H. Freeman
Professor of Electrical Engineering, Armour Institute of Technology, Chicago

IN discussing any educational system, it is important that we get rather definite ideas of the ends to be attained. Too often the objects appear to be assumed vaguely or are stated in very general terms and consequently the materials and methods selected to accomplish those objects are not as appropriate. It is the purpose of this discussion to point out a few of the aims and methods in technical education as they are being developed not only in educational institutions but also in educational departments of commercial and industrial organizations.

We may obtain more definite ideas of the objects of any system of education if we determine the qualities which are to be developed in those who follow such a system of education. And if we select a list of qualities, we can then choose materials and methods with the incentive to develop as much as possible, some or all of these qualities. Should we desire to have those who take the educational course acquire information only, we would prescribe a series of lectures, accompanied by a study of text books, hand books and encyclopedias. If we want to develop resourcefulness, we would see that information is supplied and, in addition, that continual practice is afforded in applying this information in analyzing and solving a wide variety of problems connected with the subject studied.

What is the Proper Objective?

Lists of desired qualities have been prepared by many persons. Some lists are the result of individual effort only and others represent the composite of a group. Perhaps the most extensive compilation in this line was made some years ago by Dr. C. R. Mann in connection with his investigation of engineering education for the Carnegie Foundation. Since this list of qualities was the result of such an extensive investigation, it seems desirable to refer to it in some detail and use it as a basis for further discussion. Dr. Mann asked a large number of persons whom he considered competent to state the qualities they desired in young engineering graduates. From 1,500 replies he arranged the qualities in six groups and condensed the number without much loss of value to a more practical number. He again asked a selected list of persons to rank these six groups in the order of their value. From over 5,000 replies he was enabled to weight the different groups of qualities with numerical values. The qualities with weights are given below:

Character, integrity, responsibility, resourcefulness, initiative	24.0
Judgment, common sense, scientific attitude, perspective	19.5
Efficiency, thoroughness, accuracy, industry	16.5
Understanding of men, executive ability	15.0
Knowledge of the fundamentals of engineering science	15.0
Technique of practice and of business	10.0
	100.0

This list indicates what is expected of young men who have taken a technical course, and it shows that many of these qualities are quite general in their character so that the list may be used as a measure of the value of the product of almost any system of education calling for a certain amount of specialized training. Since this schedule is the composite of many opinions of desirable qualities and appears to be so general in its application, we shall use it as a guide in discussing materials and methods for an educational program.

It is interesting to note that in this list of qualities, technical knowledge has a decidedly minor value. This

does not mean that technical educational is necessarily of minor importance, but it does show that technical education increases greatly in value as it extends its efforts and attains results beyond that of merely supplying technical information. If it can help in developing qualities of character, judgment, etc., it has an opportunity to become of major importance.

The suggestion may be made that we should not expect everything from any educational course occupying a comparatively short time and limited to specialized studies. Also, it may be urged that heredity and previous education and environment will have had their effect in influencing certain qualities sometimes in an undesirable way. It is admitted that there will be found cases where subsequent education will be handicapped by previous conditions but this should not prevent us from attempting improvement even though the chances of making them may seem rather slim. In trying to develop the desirable qualities through education of any kind, it is important to note that interest is the most powerful incentive in the student and it should be used to the fullest extent. It is much more effective to have the student driven from within than from without. It is also worth noting that the student's interest is mainly in acquiring information. He thinks he is taking the course of study for that purpose, so that educational efforts must center mainly about information as a nucleus and use it as an incentive in training other qualities.

Interest Can be Stimulated Through Association

Interest is usually the result of a natural liking for the subject-matter but it may be aroused and stimulated by association with others in the same line of work. Herein lies one of the great advantages of group meetings such as we have in class rooms, laboratories and conventions. It is not to be inferred that individual work shall be excluded from educational effort for no one denies the value of that kind of work; both individual and group work have their advantages and each should be used.

Another feature which helps in maintaining interest is definiteness. This applies particularly to young men. Youth likes to be positive and a problem which can be answered by a definite statement or a numerical value has a greater appeal than one which can be answered only by guesses or estimates, however scientific these may be. While we have many problems in life which can not be so answered, this type of problem must be introduced gradually, later in the course. If a proposition is to be proved, it is better to state it and what is to be proved and then follow with the proof than to offer the proof first and the proposition to be proved as the final conclusion; though the latter may seem the more logical, it is the less interesting. Interest is also assisted and resourcefulness and initiative developed if the importance of finding simplified ways of doing things is emphasized. Everyone is intrested in short cuts in economical ways of getting results. The student's interest in this line can be developed by illustrative examples and practice.

Having considered some of the aims and methods, we shall now give some attention to the character of the material that may be used. This character is to be governed by the objects to be accomplished and by the peculiarities of the individuals upon whom we are working. Let us see what possibilities exist in a carefully selected series of practical problems accompanied by text books and other references. Problems, or jobs, to be worked on paper or developed in material, can be chosen to do the following things:

(1) They can supply information both as to principles and to practice either by direct statement accompanying the problem or by references to magazines or text books.

(2) They thus satisfy the immediate interest of the student in furnishing information and this information will be retained better than it would be if studied apart from the application in the problems.

(3) By the effort to solve problems the student will train certain qualities of character, particularly resourcefulness—that ability to apply knowledge which we recognize as an extremely important quality. With the growth of information and the power to use it, there develops a confidence which stimulates initiative and responsibility, two other very valuble qualities of character. To what extent, if any, the solving of problems has in the development of integrity, the remaining quality of character given in our schedule, may be open to question; but it does not seem unreasonable to suppose that the study and application of natural laws may unconsciously have a beneficial reaction in the observance of moral laws.

(4) Certain kinds of problems can improve the qualities listed in the group with judgment. These in general call for the weighing of values which are not or can not be expressed numerically. Their solution depends to a considerable extent upon experience so that we can not hope to accomplish a great deal with the inexperienced, but the problems can do as much, if not more, than any other material.

(5) In finished solutions requiring numerical answers, they can assist in developing accuracy and thoroughness when these solutions are checked and criticized by a competent instructor. By the interest which they arouse, they promote industry; and, with judicious leadership, increase efficiency.

(6) In problems involving both technical and business phases, some information about business practice may be given.

It is thus indicated that we can, by a properly selected list of problems, improve all of the groups of qualities in our list except that dealing with men. This requires subjects usually considered outside of technical couses but which should be included. Psychology, economics, industrial organization and management and the experience of every day life will furnish material for the solution of problems in the understanding of men and developing executive ability.

Practical Problems Have the Greatest Appeal

In order to make problems as effective as they should be, they must be carefully chosen. Usually, made-up or artificial problems are to be avoided as much as possible, since they are always deficient in interest. Practical problems taken from the field of experience are much better in their appeal to the student and therefore give better results. Another consideration in choosing problems is the amount of mechanical work needed in proportion to the amount of mental effort required. Unless the development of skill in mechanical or mathematical processes is the primary object, the problems should require a relatively small amount of mechanical work for their solution and a relatively large amount of mental effort. In this way, training in qualities of character and judgment goes along with the accumulation of technical knowledge. Still another quality of problems to consider is length. For beginners, several short problems are much better than one long problem. Interest is more easily sustained with short problems and a wider variety of topics can be covered. Long problems are suitable for the more experienced and can demonstrate co-ordinations not possible with short ones, though they should not be used exclusively.

Carefully graded problems, or jobs, possessing the characteristics indicated are extremely effective material in any technical program of education. They are much richer in possibilities of developing desirable mental qualities than is the formal study of a text. It is not to be inferred that text book study should be abandoned, but that such study should be co-ordinated with well-designed problem work. In many cases, if text book study be made secondary in rank, an improvement of the educational work, considered as a whole, will result.

Report of Committee III—Power Interlocking

In addition to the joint report with the Committee on Mechanical Interlocking on the factors which govern in determining the type of interlocking facilities which should be installed at any location, this committee submitted a partial revision of a specification for the installation of an electric interlocking system. The drawings which the purchaser must provide are an essential part of the specifications. All apparatus not covered by the purchaser's drawings which the contractor proposes to furnish must be covered by contractor's drawings and catalog references. In general, the revised specification is more detailed in its requirements. F. W. Pfleging, signal engineer, Union Pacific, Omaha, Nebr., has held the chairmanship of this committee for five years.

F. W. Pfleging
Chairman

THE committee submitted for discussion a report on: 1. Partial revision of specification for electric interlocking. It is the intention that this revised specification, when completed, shall supersede material now in the Manual which is not adequate in many respects.

Installation of Electric Interlocking System

1. Details of Work. (a) Details of work includes the following:: 1. Buildings. 2. Power supply.
3. Distributing system: (a) Aerial. (b) Surface. (c) Underground. (d) Submarine.
4. Control apparatus.
5. Interlocking machine.
6. Switch operating mechanism and fittings.
7. Signals.
8. Wire and Cable.
9. Instrument and battery shelters.
10. Insulation.
11. Special items.

2. Detail and unit specifications. (a) Specifications referred to herein form an essential part hereof.

3. Drawings. (a) Purchaser's drawings form an essential part of these specifications and shall contain the following information:

1. Station maps drawn to scale showing track arrangement and surroundings; pole line or or other supports for line wires or aerial cables; approximate number of poles per mile; approximate average distance of nearest pole from each signal or relay box to which line wire connections are required; notations showing the sections of rail and drilling of rail joints. Drawing.....dated.....

2. Track and signal plan drawn to scale showing tracks with grades and alignment; interlocking stations; existing and proposed signals designating type, numbers, and operating characteristics; existing and proposed switches; derails and movable frogs designating their normal position and whether interlocked or non-interlocked; power stations; electric and pneumatic power mains; steam and electric railway crossings; highway crossing signals; track circuit limits and such other information as is desirable. Drawing .....dated.....

3. Circuit plans for existing installations in the territory to be signaled. Drawing.....dated.....

4. Plans showing location of battery and transformer housings, junction posts and relay locations. Drawing .....dated.....

5. Plans showing typical circuits for the control of power operated signals; switch indicators; protection for facing and trailing switches; main line and siding crossovers; highway crossing signals; train order signals and other devices. Drawing.....dated.....

(b) Contractor's drawings.

1. The contractor shall furnish with his proposal, drawings or catalogue references for the apparatus he proposes to furnish, which are not covered by the drawings furnished by the purchaser.

2. Within.....days after the award of contract and before the work is begun, the contractor shall furnish for the approval of the purchaser, the drawings specified herein.

3. Within.....days after receipt of the drawings, the purchaser will indicate any corrections that may be necessary, or signify his approval.

4. The contractor shall be responsible for the correctness of all drawings furnished by him although the drawings may have been approved by the purchaser.

5. Any work done by the contractor prior to the approval of the contractor's drawings will be done at the contractor's risk unless previously authorized in writing by accredited representatives of the purchaser.

6. After completion of contract the contractor shall furnish to the purchaser reproduced tracings, corrected tracings and or vandyke prints of drawings furnished by him.

7. No change will be made in any approved drawing without the written consent of the purchaser.

(c) After the contract is awarded each party shall furnish to the other, as required, prints of his approved drawings.

(d) Framed track diagram and manipulation chart shall be furnished in place by purchaser, in interlocking station.

4. Furnished by the Purchaser. (a) The purchaser will furnish material or labor or both as indicated below, subject to the inspection of contractor, who shall state any objections thereto before starting his part of the work. After rectification by the purchaser of any defects reported, the contractor shall assume full responsibility for the proper functioning of the installation. The intent of this section is to bar any claim by the contractor that the work done by the purchaser has not been performed in such manner as to enable him to fulfill all of the provisions of the contract.

(b) The purchaser will or will not furnish material or labor or both as indicated by "yes" or "no", on the items listed below:

Item	Matl.	Labor
1. Ties for support of apparatus	.....	.....
2. Move ties as may be necessary	.....	.....
3. Move switch and tie rods as may be necessary	.....	.....
4. Rail insulation	.....	.....
5. Bridge insulation	.....	.....
6. Switch rod insulations	.....	.....
7. Tie-rod insulations	.....	.....
8. Gauge plate insulations	.....	.....
9. Cement material		
(a) Cement	.....	.....
(b) Sand	.....	.....
(c) Stone	.....	.....
(d) Water	.....	.....
10. Necessary grading and drainage	.....	.....
11. Excavation of solid rock	.....	.....
12. Poles for line wire	.....	.....
13. Cross-arms, pins, insulators and fittings	.....	.....
14. Line wire	.....	.....
15. Insulated Wire	.....	.....

16. Battery shelters ....

Item	Matl.	Labor
17. Signal bridges	.....	.....
18. Cantilevers	.....	.....
19. Cables.		
(a) Aerial	.....	.....
(b) Submarine	.....	.....
(c)	.....	.....
(d)	.....	.....
20. Apply necessary attachments to signal apparatus in service	.....	.....
21. Make necessary alterations in any part of existing structures or apparatus.	.....	.....
22. Unload and properly house material that arrives on the ground before the contractor's force; this work to be done under the supervision of the contractor's representative	.....	.....
23. Distribute material	.....	.....
24. Obtain necessary permits from federal state, and municipal authorities	.....	.....
25. Switches, derails and movable point frogs of the required throw	.....	.....
26. Tools, fixtures for buildings and supplies required for the maintenance of the plant	.....	.....
27. Rail braces. (a) Rail braces on gauge plates	.....	.....
(b) Rail braces not on gauge plates	.....	.....
28. The purchaser will, prior to installation, furnish stakes establishing grade of foundations and main trunking runs where track is not already constructed and at a permanent grade	.....	.....
29. Foundation bolts	.....	.....
30. Number plates	.....	.....
31. Buildings, drawing.....dated.....	.....	.....
32.	.....	.....
33.	.....	.....

5. Shipment of material.

(a) No change.

6. Transportation.

(a) The purchaser will furnish transportation for men, necessary for the installation, over the following lines.....

.....

(b) The purchaser will furnish transportation for tools and materials, necessary for the installation, over the following lines .....

(c) The purchaser will furnish work train service.

7. Inspection of installation. (a) No change.

8. Tests. (a) No change.

9. Placing in service. No change. **10. Completion.** (a) No change. **11. Clearances.** (a) No change.

12. Alternate requisites. (a) Alternate section 6527 forms a part hereof.

30. Dielectric requirements. (a) Electrical apparatus assembled shall withstand for one minute an insulation test, at place of manufacture, of 3,000 volts a.c. between all parts of electric circuits and other metallic parts insulated therefrom.

(b) A surface leakage distance of not less than ¼ in. shall be provided between any exposed metallic part of the apparatus carrying current and any other metallic part thereof.

(c) Separate windings, which are insulated from each other, shall withstand for one minute an insulation test of 3,000 volts a.c. between their terminals.

31. Identification. (a) No change. **32. Insulation.** (a) No change.

DETAIL PROVISIONS

50. Foundations. (a) Foundations shall be provided by the..... in accordance with specifications and drawings.....dated.....

51. Interlocking station. (a) Building shall be provided by.....in accordance with specifications and drawings.....dated.....

52. Power house. (a) Building shall be provided by the .....in accordance with specifications and drawings .....dated.....

54. Lighting. (a) Lighting shall conform to purchaser's specifications.....dated.....

(b) • Wiring, fixtures, accessories and installation for electric lighting shall be in accordance with the rules of the National Board of Fire Underwriters and the requirements of the local authorities.

59. Power available. (a) Electric. 1. Purchaser will furnish.....volts a.c..... phase ..... cycles at points as shown on drawings accompanying these specifications.

60. Plant (a) Power plant. 1. The power plant shall consist of .....

2. .....shall be furnished by..... and installed by.....

3. .....shall be furnished by..... and installed by.....

(b) Auxiliary power plant 1. Auxiliary power plant when required shall consist of.....

2. .....shall be furnished by..... and installed by.....

3. .....shall be furnished by..... and installed by.....

65. Generator. (a) The electric generator shall be in accordance with R.S.A. Specification 1411.

70. Motor. (a) The motor shall be.....k.w. approximate equivalent.....h.p. with a rated speed not to exceed.....r.p.m. if direct current or 1,800 r.p.m. if alternating current, and shall have automatic regulation to within.....per cent when operating on .....to.....volts d.c. or on..... to ..... volts ..... cycles ..... phase phase a.c. shall be in accordance with R.S.A. Specification 1411 regarding heating, sparking and insulation, and shall be furnished with a starting panel.

75. Motor generator. (a) Motor generator shall be direct connected, mounted on a cast iron sub-base and shall conform to R.S.A. Specification 1411 (Sections 65 and 70).

80. Transformer. (a) Transformer shall be in accordance with A.R.A. Signal Division Specification 8319.

81. Battery charging rectifier. (a) Battery charging rectifier shall be of a type approved by the purchaser, and shall operate without overheating or causing deterioration of the insulation or parts when operated at maximum capacity.

85. Storage battery. (a) Storage battery shall consist of ..... set(s) ..... cells of lead acid type .....ampere hour capacity.

(b) Lead type storage battery shall be in accordance with R.S.A. 1340, A.R.A. Sig. Sec. 1224B, 1241B and 1341B.

(c) The installation, initial charge, maintenance and operation shall conform to A.R.A. Signal section Instructions for Installation, Maintenance and Operation of Lead Acid Type Storage Batteries.

(d) The ..... shall furnish with each set of battery, one hydrometer, one battery thermometer and two extra jars.

(e) Supports for batteries shall be furnished in place by the ..... and shall conform to drawing ....., dated.....

(f) The initial charge shall be conducted by the .... Current at the proper voltage for initial charge shall be provided by.....

90. Switchboards and equipment. (a) Switchboards and equipment shall be in accordance with R.S.A. Specification 6217.

(b) The installation and operation of switchboards and equipment shall conform to R.S.A. Instructions for Installation and Operation of Switchboards.

100. Machine. (a) Levers and, or spare spaces, shall be numbered consecutively from left to right.

(b) Like parts of machine of same type shall be interchangeable.

(c) Size of frame shall be: 1. Spaces required to operate all interlocked units plus ..... per cent, plus sufficient extra spaces to make a standard frame.

Committee: F. W. Pfleging (U. P.), chairman; E. T. Ambach (B. & O.), vice-chairman; W. C. Sibila (N. Y. C.), vice-chairman; F. J. Ackerman (K. C. T.), T. A. Allan (C. N.), R. B. Amsden (I. C.), D. W. Fuller (A. T. & S. F.), T. Holt (C. U. S.), J. H. Oppelt (N. Y. C. & St. L.), E. B. Pry (Penna.), C. D. Rex (Sou.), T. C. Seifert (C. B. & Q.), I. A. Uhr (St. L.-S. F.), O. R. Unger (M. P.), and G. A. Ziehlke (U. P.).

Discussion

F. W. Pfleging (U. P.), chairman: We have given details of labor and drawings not heretofore included in previous specifications. Materials and labor are consolidated into one item, so that the item, whether it is labor or material, can be specified. The committee has had inquiries on assignment four and has canvassed several of the installations which are in service, and the committee would like to have typical plans of any proposed automatic interlocking at railroad grade crossings.

[As the report was presented for discussion only, the committee was then excused with the thanks of the association.]

Report of Committee XI—Chemicals

The proper type of battery supply for signal operation is one of the chief subjects which this committee has studied, although oils and insulating materials are also within the scope of its work. A real contribution to the signaling field has resulted from the committee's efforts to provide a new specification for caustic soda primary cells and renewals. Of particular interest and importance are the sections referring to inspection and tests. Capacity and polarization tests are covered. Adherence to these requirements on the part of battery manufacturers will guarantee primary cells capable of proper service performance under all normal operating conditions. I. S. Raymer, signal engineer, Pittsburgh & Lake Erie, Pittsburgh, Pa., was appointed chairman of this committee in November, 1923.

I. S. Raymer
Chairman

THE committee submitted for consideration: Specifications for caustic soda primary cells and renewals. These superseded A. R. A. Signal Specification 8720—Type-A Caustic Soda Primary Cells and Renewals. The committee recommended their acceptance for submission to letter ballot superseding the subject-matter in the Manual.

Caustic Soda Primary Cells and Renewals

1. **Purpose.** (a) The purpose of this specification is to provide, for signal system, a standard voltage caustic soda primary cell, using copper oxide as the positive electrode and depolarizer and amalgamated zinc as the negative electrode in a solution of sodium hydroxide, no ingredient being introduced which materially alters the voltage of the cell.

2. **Designation.** (a) Cell shall be known as A. R. A. standard voltage primary cell and shall be designated by the letters A. R. A. followed by the rated capacity in ampere hours.

(b) Each cell shall include the following parts: (1) Assembled unit; (2) can of caustic soda; (3) bottle of oil (when not otherwise provided for); (4) one hexagonal nut, two wing nuts and two washers; (5) cover, and (6) jar.

(c) Each renewal shall include the following parts: (1) Assembled unit; (2) can of caustic soda, and (3) bottle of oil when not otherwise provided for.)

3. **Jars.** (a) Jars shall be in accordance with drawings 1053 or 1419 unless otherwise specified, and A. R. A. Sig. Sec. Spec. 11321.

4. **Wing nuts, etc.** (a) Washers, nuts and bolts shall be in accordance with drawing 1053 and R. S. A. 1070.

5. **Assembled units.** (a) Units shall consist of positive and negative electrodes rigidly supported, insulated and equipped with connecting wires and suspension bolts.

(b) Suspension bolts shall be in accordance with R. S. A. 1070 and shall extend 1⅛ in. above the top of the cover when the unit is tightened to cover.

(c) Negative connections shall be not smaller than No. 12 A. W. G. soft-drawn insulated copper wire and of such length as to extend 12 in. through cover.

6. **Inspection.** Standard section.

7. **Tests.** (a) Tests may be made at point of production, or on samples submitted, and may also be made a destination.

(b) Contractor shall give the purchaser sufficient notice of time when material will be ready for testing.

(c) Contractor shall provide, at point of production, apparatus and labor for making the required tests under supervision of the purchaser.

(d) Test cells shall be selected at random by picking out not more than 10 or less than 2 cells for each test.

(e) A. R. A. Signal section instructions for installation and handling of caustic soda batteries shall be followed. Excepting as hereinafter modified, tests shall be made in jars in accordance with drawings 1053 or 1419, reference 10532 or 14192 for 500 a.h. capacity, 10535 or 14191 for 1,000 a.h. capacity, and by using 4,400 c.c. of soft water for 500 a.h. and 8,000 c.c., of soft water for 1,000 a.h. cells. Assembled units must be submerged in electroylte ¼ in. If above quantities of water will not accomplish this, units must be lowered to proper level.

(f) Tests may be made at higher temperature, except that while readings are taken the temperature of the solution measured by a floating thermometer shall be maintained within limits specified.

(g) Meters and thermometers shall be compared with standard instruments and necessary corrections made. Readings shall be recorded with explanation of irregularities.

(h) Voltage readings shall be taken across terminals of cell.

(i) Variable resistance shall be adjusted as necessary to maintain the desired discharge rate within 2 per cent.

(j) Temperature shall be maintained within 2 deg. F. of the figure shown while readings are being taken.

(k) Temperature readings will be taken with bulb of thermometer resting against outside surface of zinc, midway of element.

(l) **Capacity tests.** 1. Cells will be discharged in series through a measured circuit consisting of an ampere hour meter and a fixed resistance at a temperature of 60 to 75 deg. F., until rated capacity has been delivered. The resistance of external circuit for 500 a.h. capacity cells shall be 0.5 ohm; for 1,000 a.h. capacity cells shall be 0.25 ohm per cell. Resistance for the other capacities shall be in the same ratio. 2. Until cell has delivered 98 per cent of its rated capacity and while discharging through fixed resistance, its voltage shall not be less than 0.56 volt at 68 deg. F.

(m) **Polarization tests.** 1. Polarization tests will be made immediately after setting up, after cell has delivered 98 per cent of its rated capacity and may be made at any time during life. 2. Cell will be discharged at 68 deg. F., at 350 m.a. for 1 hr; then discharged at 3 amp. for 30 min. during which discharge voltage shall not fall below the following values at the time indicated:

At the end of 5 min. not less than 0.485 volt.
At the end of 10 min. not less than 0.480 volt.
At the end of 15 min. not less than 0.475 volt.
At the end of 20 min. not less than 0.470 volt.
At the end of 30 min. not less than 0.470 volt.

3. Cell will then be discharged at 350 m.a. over night, during which time temperature will be reduced to 34 deg. F., by being surrounded by ice or other cooling means. Cell will then be discharged at 3 amp. for 30 min. during which discharge, voltage shall not fall below the following values at the time indicated:

At the end of 5 min. not less than 0.290 volt.
At the end of 10 min. not less than 0.285 volt.
At the end of 15 min. not less than 0.280 volt.
At the end of 20 min. not less than 0.275 volt.
At the end of 30 min. not less than 0.270 volt.

(n) Cells shall not be permitted to be on open circuit at any time during or between tests.

8. **Exhausted units.** (a) Credit shall be allowed for exhausted units returned in condition substantially as they

were taken from service with such breakage as cannot be reasonably avoided in packing and handling.

(b) Manufacturer may make such inspection of the exhausted units either at factory or on the railroad as will permit him to properly check condition and number of units.

9. **Packing.** 10. **Marking** and, 11. **Warranty are standard sections.**

Committee—I. S. Raymer (P. & L. E.), chairman; A. B. Hines (B. & O.), vice-chairman; R. F. Annear (C. R. I. & P.), R. D. Ashley (I. C.), F. A Beck (Penna.), C. F. Jones (Sou.), H. L. Kilian (N. Y. C.), E. W. Kolb (B. R. & P.), H. C. Lorenzen (P. M.), S. U. Rhymer (C. & A.), D. S. Rice (L. V.), B. H. Richards (D. & H.), E. B. Smith (N. Y. C.), W. S. Storms, (Erie), and A. H. Yocum (Reading).

Discussion

J. S. Gensheimer (Penna.), contended that the proposed specification for caustic soda primary batteries was not in accord with the best practice of making polarization tests of primary cells. The provision of a test calling for certain minimum voltage limits after 97 per cent of the capacity of the cell had been reached was considered of small importance and might lead to the acceptance of batteries which would otherwise be rejected according to the present requirements of some railroads.

A. H. Rudd moved that the specification be referred back to the committee for further study and revision.

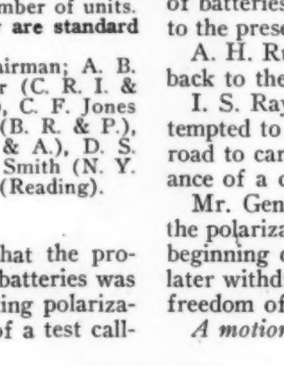
I. S. Raymer, chairman, stated that the committee attempted to draw up a specification that will allow a railroad to carry out its own tests without the skilled assistance of a chemist.

Mr. Gensheimer also suggested to the committee that the polarization tests be drafted to cover the period at the beginning of the useful life of the battery, but this was later withdrawn in order to allow the committee complete freedom of action.

A motion to approve the specification failed to pass.

Report of Committee IV—D.C. Signaling

Several factors influencing track circuit operation have been considered by this committee in an effort to effect an improvement in the reliability and safety of this important element. The increasing use of treated ties has demanded that signal engineers devote some study to the various preservative treatments with a view to determining which, if any, have any bad effects on track circuit performance.



E. N. Fox
Chairman

Treatments using zinc chloride, coal tar creosote and water gas tar were so considered by the committee. Lightning and foreign currents may also cause trouble, the former affecting particularly the track relays and resistance units. E. N. Fox, general signal inspector, Boston & Maine, Boston, Mass., was appointed chairman of this committee at the meeting in September, 1925.

THE committee submitted reports on the following subjects: 1. Effect of treated ties on track circuits; 2. Resistance of d.c. relays; 3. Effect of lightning on track circuits; 4. Effect of foreign current on track circuits; 5. The prevention of the sweating of relays; 6. The prevention of the sweating of semaphore signal mechanisms; 7. The preservative treatment of capping and grooved trunking, and a joint report with Committee VIII on fouling protection for turnouts and crossovers in automatic block signal territory.

The committee suggested that the first report on the effect of treated ties be accepted as information and recommended that the other reports be accepted for submission to letter ballot for inclusion in the Manual.

Effect of Treated Ties on Track Circuits

Treatment with zinc chloride, sodium fluoride and similar preservatives of chemical salts render ties comparatively highly conducting. Unless combined with some other material, such as creosote, these salts gradually leach out, particularly in damp climates, and eventually their influence on the resistance of roadbeds disappears. The use of ties so treated should be restricted to territory on which no track circuits are in service. If impossible to avoid their use in track circuited territory, they should be allowed to season for a period of not less than 3 months, preferably 6 months or more, before being placed in the track. If the use of unseasoned ties cannot be avoided, not more than 10 per cent should be renewed annually in track sections 3,000 ft. or less in length and a proportionally smaller percentage in longer sections. If ties are seasoned as recommended herein, 15 per cent may be renewed in a section not over 3,000 ft. long.

Ties treated with coal tar creosote have a resistance somewhat lower than that of untreated ties, but it is felt that track circuits can be operated successfully where ties treated by this process are installed. Any benefit due to this treatment may be considered as due to the increased life of the tie or postponed decay.

The resistance of ties treated with water gas tar measures considerably higher than that of untreated ties, which indicates that this impregnating material affords additional insulating qualities, and, from a track circuit standpoint, ties so treated should be used in preference to all others.

Resistances of D.C. Relays

Recommended resistances for direct current neutral and polarized relays are: 2, 4, 9, 16, 50, 500, 670 and 1,000 ohms.

Effect of Lightning on Track Circuits

Lightning may cause trouble on the following elements of the track circuits:

Relays.—1. Lightning discharges will sometimes burn out the relay coils. To prevent this, a path, for the discharge of the lightning in multiple with the coils, should be provided.

2. Cases have been reported where the path of the discharge was traced as follows:

From line to finger to armature to pole piece to winding to track lead to track. This causes the following: (a) Fusing between armature and pole piece. (b) Pitting of trunnions. (c) Puncturing of coils.

2-a and 2-b may cause clear failures.

3. When the above occurs, it indicates that the line circuit lightning protection is not adequate. When all the line circuit protection feasible has been provided, the following remedy has been found beneficial:

Provide a low resistance path from the armature to the pole pieces by means of a flexible connector. This does not take

care of the puncturing of the coils. To protect the coils would require a lightning arrester. On account of the few occurrences of coils being punctured, it is considered more economical to allow the coils to be destroyed occasionally.

Resistance Used in Series with the Battery.—1. Difficulty has been experienced with non-enameled units burning out. This was overcome by the use of larger wire. It is recommended that no wire be used smaller than No. 17 Nichrome or equivalent. It is important that proper ventilation be given to dissipate the heat developed. This applies to units used for both soda and storage batteries.

Battery.—1. It is believed that lightning discharges rarely affect track batteries. A path for the discharge of the lightning in multiple with battery may be provided, if desired.

Effect of Foreign Current on Track Circuits

1. Foreign current includes all current derived from sources external to the circuit and is subdivided as follows: (a) Current from sources external to the tracks. (b) Current from adjoining track sections.

2. The following suggestions are offered to minimize the effect of foreign current from sources external to the tracks:

(a) The interference from an external source bears a direct relation to the length of the circuit. The voltage of the foreign current in the rails is due to the difference of earth potential at different points. It is therefore necessary in foreign current territory to reduce the length of the section so that the difference of earth potential will not produce enough current to operate the relay. The length of the sections to make them free from foreign current interference depends upon so many factors that no rules can be given as to the lengths to be used. The lengths should be shortened generally from the standards used in territory free from foreign current. The length depends also on the condition and adequacy of the bonding.

(b) A center fed track circuit gives greater protection against foreign current than a standard end fed circuit of the same length.

(c) Whenever the source of foreign current can be determined, such as at electric railway crossings, the track circuit battery should be placed at the end nearest the foreign current source. A track circuit must not be carried across an electric railway.

(d) Insulated joints at ends of track circuits, including those at end of fouling on side tracks, should be opposite each other.

(e) Two sets of insulated joints are recommended at foulings on tracks where foreign current is adjacent, such as where tracks are connected to or cross electric railways. The extra set of joints are to be placed one rail length away from the joints in the standard position.

(f) Insulated joints must be maintained in first-class condition.

(g) Pipe lines attached to rails must be insulated to prevent foreign current from entering the track circuit.

(h) Ballast must be kept clear from both rails.

(i) The resistance of the relay is not an important item as regards foreign current protection. Each of the resistances commonly used are equally safe.

(j) It is very essential that the bonding on electric railways in the vicinity should be kept in first-class condition. Crossings of electric railways should be bonded in accordance with drawings 1428 and 1429.

(k) Bonding should be of low resistance where foreign current is present, and must be maintained in first-class condition.

3. To prevent trouble from current from adjacent track circuits:

(a) The insulation of insulated joints must be maintained in first-class condition.

(b) Ballast must be kept free from both rails.

(c) Bonding must be maintained in first-class condition.

The Prevention of the Sweating of Relays

1. Relay housings should be nonmetallic, or metallic with nonmetallic lining, including the door.

2. Nonmetallic housings and the nonmetallic lining of metal housings should be constructed so as to close as nearly air-tight as practicable. The outside metal housing should be thoroughly ventilated by providing openings near the bottom and the top of the housing, the openings being covered with wire gauze to exclude dirt and insects, and suitably hooded to exclude rain.

3. The voids between and around the wires at the point where they enter the relay housing should be filled with a suitable compound that will seal the opening and exclude moist air from the conduit leading to the housing. Where housings with open bottoms are mounted on concrete foundations, the surface of the concrete should be covered with a suitable material to prevent the entrance of moisture into the housing.

4. Moisture-absorbing chemicals, except glycerine, should not be used in relay housings, on account of injurious corrosive action. Glycerine in a small open container placed inside the housing has been found to be beneficial.

5. Relays should be sealed as nearly air-tight as practicable.

The Prevention of the Sweating of Semaphore Signal Mechanisms

1. The outer case should be thoroughly ventilated by openings near the bottom and the top of the case, covered with wire gauze, to exclude dirt and insects, and suitably hooded to exclude rain. The inner or motor case should be enclosed as nearly air-tight as practicable.

2. The inside of the outer case should be coated with a good grade of enamel or an insulating paint. The use of a mixture of enamel and ground cork has been highly recommended.

3. The voids between and around the wires at the point where they enter the case should be filled with a suitable compound that will seal the opening and exclude moist air from the conduit leading to the case.

4. Moisture absorbing chemicals, except glycerine, should not be used in mechanism cases, on account of injurious corrosive action. Glycerine in a small open container placed inside the case has been found to be beneficial.

A joint committee representing the Construction, Maintenance and Signal sections, A. R. A., rendered a co-operative report outlining a specification for the preservative treatment of capping and grooved trunking, with the recommendation that it be accepted for submission to letter ballot.

Committee.—E. N. Fox (B. & M.), chairman; R. E. Green (M. C.), vice-chairman; C. M. Acker (D. & H.), M. A. Baird (Erie), J. H. Butridge (I. C.), Dwight Byers (N. Y. C.), G. H. Caley (N. Y. O. & W.), L. E. Carpenter (Penna.), J. J. Corcoran (N. Y. C.), A. R. Fugina (L. & N.), A. M. Gilbert (C. C. C. & St. L.), C. E. Hartvig (C. R. I. & P.), G. A. Motry (B. & O.), R. M. Phinney (C. & N. W.), A. Reilly (C. L. & W.), A. A. Stueber (C. B. & Q.), J. B. Weigel (S. A. L.), and D. C. Bettison

Discussion

E. N. Fox (B. & M.), Chairman: The report on the effect of treated ties on track circuits was presented at the stated meeting and we recommend its acceptance as information.

Chairman Post: Is there any discussion on the report? If there is none, it will be accepted as information.

Mr. Fox: The report on the resistances of d. c. relays is now presented for acceptance for submission to letter ballot, and I so move. *Motion carried.*

Mr. Fox: The committee has decided that the report on effect of lightning on bad track circuits should be rewritten in the form of a requisite. For that reason the committee desires to change the action recommended to read acceptance as information.

Mr. Fox: The same remarks apply to the next two reports. The committee intends to revise them and put them in requisite form, and for that reason the action recommended is changed to acceptance for information.

Mr. Fox: Certain minor corrections are to be made in the specification for treatment of trunking and copping.

C. A. Christofferson (N. P.): I have been treating the trunking with creosoted treatment for a good many years, but it seems the wire manufacturers have always objected and claimed they would not guarantee the insulation if it was put into creosoted trunking. I would like to know what the wire manufacturers have to say on that subject.

T. C. Seifert (C. B. & Q.): Years ago we used treated trunking and found it very unsatisfactory, as our wire deteriorated in a very short time. We have one case in our records of a wire lasting just 16 months, due to the method of creosoting.

E. T. Ambach (B. & O.): The telegraph department uses considerable creosoted wood duct. Recently we have made some tests which indicate that the creosoted duct was injurious to lead covered cable. The lead covering on the cable deteriorated. In some places it pro-

duced what might be called a lead sulphate. The investigations indicated that it was caused by acetic acid.

Mr. Fox: Answering Mr. Ambach, under 2 (b) it says: "Capping and trunking to be treated shall be ordered in accordance with R. S. A. Specification 5716." I think the point raised by Mr. Ambach will be covered in that specification.

Mr. Jones: A process has been developed by means of which creosoted duct can be taken out of the vat and shipped practically free of unabsorbed creosote. If the lead cable and, I dare say, insulated wire is pulled into a duct in which there is a great deal or a considerable amount of unabsorbed creosote, injury is bound to occur, but we do not anticipate any trouble in the use of creosoted wood duct which is used practically free. The oils used in the latest specifications for creosoting duct are now such that they are practically free from acetic acid content and the specification should so provide.

Chairman Post: The Engineering Division requested that this joint specification be prepared and it is in response to that request that this assignment was made. If there is no further discussion, it has been moved that this report be accepted for submission to letter ballot. *Motion carried.*

Report of Committee VI—Designs

Continuing the important work of standardization which this committee has been engaged in since its inception, progress was reported on the assignment to revise the Manual, several revised and new drawings were submitted including a new symbol scheme of signal operating characteristics for signaling plans, and a new specification for oil lighted lamps was presented which provides for ventilation and wind tests at the factory. To provide for the interchangeability of parts in the construction of oil lighted lamps, several new and revised drawings were submitted that covered lamps for semaphores, switch stands, trains, engines, and highway crossing gates. E. K. Post, signal engineer, Pennsylvania Railroad, Philadelphia, Pa., has been chairman of this committee since November, 1923.

E. K. Post
Chairman

THE committee submitted reports on: 1. Revision of manual; 2. Designs (revised and new drawings); 3. Symbols, signal operating characteristics, and a specification for oil lighted lamps. The committee recommended that the revised drawings be accepted for submission to letter ballot to supersede subject matter now in the Manual; that the new drawings be accepted for submission to letter ballot; that the obsolete drawings be removed from the Manual; that the drawings on lamp details be accepted for submission to letter ballot, and that the diagram of symbols, signal operating characteristics, be accepted for submission to letter ballot, superseding subject matter now in the Manual. The new specification on oil lighted lamps was submitted with the recommendation that it be accepted for submission to letter ballot.

Revised Drawings

A.R.A. Sig. Sec. 1053B—Round Jars and Cover. "Glass cover" removed. Note referring to specifications added.

A.R.A. Sig. Sec. 1545B—Mechanical Dwarf Signal—Assembly. References added. Note referring to specifications added.

A.R.A. Sig. Sec. 1552B—Base for One-Way Wall Machine. Location of rack guide changed. Note referring to specifications added.

A.R.A. Sig. Sec. 1043B—One-Arm Mechanical Ground Signal. Reference numbers changed. Note referring to specifications added.

A.R.A. Sig. Sec. 1044B—Two-Arm Mechanical Ground Signal. Reference numbers changed. Note referring to specifications added.

A.R.A. Sig. Sec. 1045B—Three-Arm Mechanical Ground Signal. Reference numbers changed. Note referring to specifications added.

A.R.A. Sig. Sec. 1362B—Ladder Parts. Bolt holes added in 13622. Note referring to specifications added.

A.R.A. Sig. Sec. 1372B—Ladders for Bracket Posts. Section 137211 added and holes added in 137210. Note referring to specifications added.

Drawings to Be Made Obsolete

R.S.A. 1190—Mechanical Connections for 6-Way Bracket Post.

R.S.A. 1191—Mechanical Connections for 3-Arm Bridge and Bracket Masts.

New Drawings

A.R.A. Sig. Sec. 1565A—Latch Shoe and Latch Rod Assembly.

A.R.A. Sig. Sec. 1566A—Latch Shoe and Latch Rod Details.

A.R.A. Sig. Sec. 1567A—Mechanical Dwarf Signal—Details.

A.R.A. Sig. Sec. 1568A—Mechanical Dwarf Signal—Details.

A.R.A. Sig. Sec. 1583A—Ladders for Ground Masts.

A.R.A. Sig. Sec. 1584A—Ladders for Bracket and Bridge Masts.

A.R.A. Sig. Sec. 1585A—Ladder Parts.

A.R.A. Sig. Sec. 1586A—Locking Bar Splice—S & F Machine.

A.R.A. Sig. Sec. 1587A—Adjustable Lock Rod.

New and Revised Lamp Drawings

The committee submitted the following new and revised drawings for oil lighted lamps to provide for the construction of lamps having interchangeability of parts:

A.R.A. Sig. Sec. 1100B—Semaphore Lamp—One Lens.

A.R.A. Sig. Sec. 1101B—Oil Fount.

A.R.A. Sig. Sec. 1430B—Semaphore Lamp—Two Lens.

A.R.A. Sig. Sec. 1440B—Switch Lamp (Spherical Type).

A.R.A. Sig. Sec. 1442B—Lens Hoods and Couplings for Switch and Semaphore Lamps.

A.R.A. Sig. Sec. 1443B—Oil Fount (For Spherical Type Lamp—Plan 1440).

A.R.A. Sig. Sec. 1445B—Switch Lamp Disc.

A.R.A. Sig. Sec. 1460B—Switch Lamp (Cylindrical Type).

A.R.A. Sig. Sec. 1461B—Switch Lamp Base-Socket.

A.R.A. Sig. Sec. 1470B—Train Marker Lamp.
A.R.A. Sig. Sec. 1480B—Engine Signal Lamp—Four Lens.
A.R.A. Sig. Sec. 1497B—Highway Crossing Gate Lamp Fount and Lens Hood.
A.R.A. Sig. Sec. 1499B—Highway Crossing Gate Lamp.
A.R.A. Sig. Sec. 1592A—Lamp Details.
A.R.A. Sig. Sec. 1593A—Lamp Details.
A.R.A. Sig. Sec. 1594A—Lamp Details.
A.R.A. Sig. Sec. 1595A—Lamp Details.
A.R.A. Sig Sec. 1596A—Lamp Details.

Symbols, Signal Operating Characteristics

A.R.A. Sig. Sec. 1571A—Symbols, Signal Operating Characteristics. To supersede Plate 1, Symbols for Signals now in the Manual.

Oil Lighted Lamps

1. **Purpose.** (a) The purpose of this specification is to provide for the construction of lamps having interchangeability of parts.
2. **Drawings.** (a) Drawings of lamps and parts thereof shall form an essential part of this specification.
3. **General requirements.** (a) Lamps shall have top draught ventilation. (b) Lamp bails shall be made of No. 4 (.2043) A.W.G. steel wire. (c) Top of bail shall extend 4½ in. above top of dome with a 3½ in. radius. (d) Insect screen shall be provided when specified.
4. **Tinning.** (a) Method of tinning shall be as follows: 1. Sheet steel parts before assembling shall be dipped in solution of muriatic acid, redipped in solution of tinning flux, then immersed in a lead tin alloy, containing not less than 40 per cent nor more than 50 per cent pure lead.
5. **Japanning.** (a) Finished lamp shall be cleaned with a suitable cleaner to remove all grease and then sprayed outside with black baking japan. After spraying they shall be baked at an even temperature at a minimum of 250 deg. F. for a sufficient length of time to secure a hard, durable finish.
6. **Switch lamp discs.** (a) Discs shall be provided when specified and enameled as follows: 1. Dip in pickling solution to remove all scale and surface rust, apply a ground coat and two finishing coats of vitreous enamel and bake at high temperature a sufficient length of time to secure a hard and durable finish.
7. **Material and workmanship.** 8. **Inspection.** 9. **Tests.** 10. **Packing.** 11. **Marking,** and 12. **Warranty,** are standard sections.

Commitee—E. K. Post (Penna.), chairman; C. F. Stoltz (C. C. C. & St. L.), vice-chairman; C. A. Christofferson (N. P.), vice-chairman; C. J. Kelloway (A. C. L.), B. H. Mann (M. P.), J. C. Mock (M. C.), C H. Morrison (N. Y. N. H. & H.), F. P. Patenall (B. & O.), F. W. Pfleging (U. P.), E. J. Relph (N. P.), J. E. Saunders (D. L. & W.), and G. K. Thomas (A. T. & S. F.).

Discussion

E. K. Post (Penna.), chairman: I move that the new drawings be accepted for insertion in the Manual.

Motion carricd.

A motion to accept the revised drawings *was carried* and a like motion to remove obsolete drawings from the Manual *was carried.*

There was an extensive discussion on the twelve drawings for oil lighted lamps, including signal, switch, engine and train lamps. J. A. Peabody (C. & N. W.), pointed out that the idea of such standardization had been tried out during the U. S. Railroad Administration and had failed. A question was raised as to the necessity for changing the size of the lens.

A motion to adopt these drawings for letter ballot for inclusion in the Manual, *was carried.*

(The committee was excused with the thanks of the Signal section.)

Joint Report on Fouling Protection

THE subject of proper fouling protection for turnouts and crossovers in automatic block signal territory was considered by a joint committee composed of members of Committee IV—D. C. Automatic Block Signaling and Committee VIII—A. C. Automatic Block Signaling. They submitted a report for the purpose of discussion.

To secure fouling protection at turnouts the report includes a new standard drawing, A. R. A. Sig. Sec. 7004. For protection at crossovers a new standard drawing, A. R. A. Sig. Sec. 7005, was included in the report. Sketches 1 and 4 of this drawing shown herewith were presented as recommended practice, except where additional protection is desired on crossovers between main tracks, in which case Sketches 2 and 3 were recommended.

Sufficient protection for movements of light engines or cars through main track crossovers in automatic block signal territory is provided, according to the joint report, by the observance of the A. R. A. Standard Code Rule 511. Additional protection, however, is desirable, the report stated. At turnouts and crossovers, proper fouling protection can be obtained, according to the report's recommendations, by the method illustrated in a new drawing, A. R. A. Sig. Sec. 7006.

Committee IV—E. N. Fox (B.. & M.), chairman, R. E. Green (M. C.), vice-chairman, C. M. Acker (D. & H.), M. A. Baird (Erie), J. H. Butridge (I. C.), Dwight Byers (N. Y. C.), G. H. Caley (N. Y. O. & W.), L. E. Carpenter (Penna.), J. J. Corcoran (N. Y. C.), A. R. Fugina (L. & N.), A. M. Gilbert (C. C. C. & St. L.), C. E. Hartvig (C. R. I. & P.), G. A. Motry (B. & O.), R. M. Phinney (C. & N. W.), A. Reilly (D. L. & W.), A. A. Stueber (C. B. & Q.), and J. B. Weigel (S. A. L.), and D. C. Bettison.

Committee VIII—C. H. Morrison (N. Y. N. H. & H.), chairman, L. F. Vieillard (L. I.), vice-chairman, T. N. Charles (Sou.), J. H. Deming (C. of G.), G. H. Dryden (B. & O.), W. F. Follett (N. Y. N. H. & H.), E. N. Fox (B. & M.), C. E. Goings (Penna.), J. J. Larkin (S. B. R.), W. K. Saunders (R. F. & P.), F. E. Wass (G. C. T.)

Discussion

E. N. Fox (B. & M.) chairman: I have received several letters which indicate that the writers were under the impression that the committees were recommending the breaking of signal circuits. The committees have not done this.

C. A. Christofferson (N. P.): We found that breaking line controls created a lot of trouble on account of grounds, and we condemned the practice as unsafe. So we have for the last 14 or 15 years used a shunt and break on all our single tracks and all our facing points on double track and on multiple track we shunt the switches.

Now as to line break, that special condition, we do use in a very few cases, and inasmuch as it is a special condition, it seemed to me that it should not be shown in the Manual.

A. H. Rudd (Penna.): There is a foot-note C, main track circuits shunted by and or signal control circuits broken through contacts with switch circuit controls. Now that is supposed to provide an alternative that you can shunt and break or you can break alone or you can shunt alone as I understand it. Our scheme is the same except we don't break our lines through. We don't believe in breaking the lines through if we can help it.

H. G. Morgan (I. C.): I want to join Mr. Rudd in his suggestion. I think that most of those who protested this arrangement as shown in the plan protested it because they felt that the shunt alone should be used and that breaking the line control wires was not good practice.

J. A. Peabody (C. & N. W.): I object, if they want that. I will agree to the three sketches, but we are using the broken line wires through our switch boxes. We be-

lieve in it thoroughly and think it is the proper thing to do.

Mr. Fox: Among the members of Committee IV, a pole taken indicated that 55 per cent. of the roads were shunting only, about 30 per cent. were both shunting and breaking and about 15 per cent. were breaking.

E. G. Stradling (C. I. & L.): It appeals to me that the diagram is more noticeable and more apt to be used as a guide than the notes, and I think that we ought to have the three sketches showing the shunt that Mr. Fox mentioned.

Mr. Fox: The committee is entirely agreeable to making separate sketches.

Mr. Rudd: I move that the three sketches be made. *Motion carried.*

The committee was excused with the thanks of the Signal section.

Report of Committee VIII—A.C. Signaling

The subjects included in this committee's jurisdiction are becoming increasingly important each year with the introduction of alternating current train control systems. To obtain information on train control transmission lines, particularly as to voltages used, frequencies employed and types and sizes of conductors installed, various railroads were circularized with a questionnaire. The matter of inductive interference of a. c. circuits and supply lines upon communication circuits was the subject of a joint study with committees of the Telegraph and Telephone section. This dealt largely with the question of grounding the center tap of transformer secondaries, which would cause signal failures. C. H. Morrison, signal engineer of the New Haven, has been chairman of this committee for 12 years.

C. H. Morrison
Chairman

THE committee submitted reports on: 1. Alternating current circuits and apparatus as applied to train control; 2. Inductive interference of a.c. circuits and supply lines for signal and train control with communication circuits, conferring with the T. & T. section, A. R. A.; 3. Protection from lightning, and 4 A revised diagram showing a method of calculating ballast resistance. The committee recommended that all of these reports be accepted for discussion, excepting that on lightning protection which was offered as information.

Alternating Current Circuits and Apparatus as Applied to Train Control

Various railroads throughout the country which have in service, or are installing train control devices, have been circularized for information in connection with this assignment. Forty replies were received, the summary of replies being as follows:

1—Not ready to answer.

17—The train control system installed does not necessitate the use of transmission lines or alternating current.

22—Train control transmission lines.

(a) **Voltage:** 6—4,400; 1—6,600; 3—550; 1—2,300; 3—2,200; 2—4,600; 1—440; 1—460; and 1—110.

(b) **Approximate length:** From 3 miles on the Long Island to 227 miles on the Atchison, Topeka and Santa Fe.

(c) **Frequency:** 19—60-cycle; 2—100-cycle; and 1—140-cycle.

(d) **Approximate load:** Current from 0.2 amp. to 10 amps.

(e) **Cross-section of conductors:** 10—with No. 6 wire, copper; 4—with No. 4 wire, copper; 2—with No. 4 wire, aluminum, reinforced; 1—with No. 8 wire, copper; 2—with No. 10 wire, copper; 2—with No. 2 wire, copper; and 1—with No. 2/0 wire, copper.

(f) **Conductors transposed:** 9—Yes, and 13—No.

(g) **Open wires, or duplex construction:** 22—Open.

(h) **Location of lines. If on lines of communication, have tests been made to determine if there is any voice induction or "cross-talk"?** 12—On lines of communication. The same 12 report no interference; 10—On separate poles.

The maximum power conditions on lines of communication is on the Reading—4,400 volts, 3-phase, 60 cycles, 55 miles, No. 6 A.W.G. wire, 2.25 amps., transposed at frequent intervals, with an overhead ground wire is used. No interference reported.

Inductive Interference of A. C. Circuits and Supply Lines for Signals and Train Control with Communication Circuits

On December 2, 1925, W. F. Follett, chairman of the subcommittee, attended a joint meeting of Committee IV—Electrical Protection, and Committee VII—Inductive Interference, both of the Telegraph and Telephone section. The principal part of the conference of the day was devoted to a discussion of grounding the center of a service transformer, feeding a signal power circuit of more than 2,900 volts, special stress being given to the matter of 4,400 volts, this being the commercial voltage that is usually used.

All members of the Telegraph and Telephone section's committees urged the grounding of the center of the secondary coils feeding the signal power circuit so that the grounding of either power wire would limit the voltage between the other wire and ground to one-half full voltage.

Mr. Follett refused to endorse such a scheme for the reason that the establishment of a permanent ground on a power system, as desired by the Telegraph and Telephone committees, would provide a means whereby, if either of the power wires of the signal transmission line became slightly grounded, it would affect the signal system throughout the entire length of the power circuit. A slight ground would probably cause track circuit failures and relay failures, resulting in intermittent signal failures, whereas a heavier ground or a good ground would reduce the voltage of the signal system one-half, which would result in all signals taking the stop position and the lights would practically go out.

Committee VIII's representative contended that to install such a scheme would serve no purpose except to limit the voltage on the communication lines in case of two failures, namely: A ground on one side of the signal transmission line simultaneous with a cross between the other side of the transmission line and a communication wire. On the other hand, a permanent ground, as requested by the Telegraph and Telephone section, committees would create a condition whereby a reduction in the dielectric strength of the transmission line would cause signal failures and a fairly good ground would cause entire interruption to the signal system. This not only would be very detrimental from an economic stand-

point in the operation of trains, but would be demoralizing to the enginemen and would, to a certain extent, create a hazard on account of stopping trains at points where they were not scheduled to stop.

As a result of the conference, the chairman of the joint meeting appointed a sub-committee of members of both Committees IV and VII of the Telegraph and Telephone section, to confer with Committee VIII of the Signal section, with a view of discussing the point in question further.

Protection from Lightning

A general discussion of the developments in lightning protection and recommended practices was presented by the committee. An abstract of this report follows:

Lightning protection in signal work may be divided generally into four classes: That required for the first and second, the third and fourth, and the fifth voltage stage, line and underground circuits and track circuits.

Guarding against lightning consists largely of the use of a ground wire, by distributing the stress on instruments affected by using shields, by increasing the value of the insulation, and by the use of arresters. For some circuits it might be advisable or necessary to use all of these methods, for others only one of them may be required.

It may be taken for granted that no protection of great value can be afforded against direct lightning strokes. They are rare occurrences and when they do happen the protective apparatus, as well as the instrument to be protected are usually destroyed.

The matter of lightning protection narrows down, therefore, to getting rid of what is known as the bound charge. Briefly this is the charge which has been electro-statically induced on the line by the electrical stress existing between the earth and a charged cloud. A lightning stroke releases this charge, the energy of which is free to travel over the system, and the effect is the same as the sudden application of enormous voltage between line and ground.

Ground Wire

Probably the simplest form of overhead line protection is the ground wire. The use of this device has been argued and discussed for a number of years and until lately the opinion as to its efficiency was about evenly divided, several polls of the corporations operating transmission systems resulting in a 50-50 vote. In recent years, however, the research work of experts in the employ of the large electrical companies has apparently proven that the ground wire is certainly of considerable benefit and it is recommended for general use.

It has been shown in the laboratory that under favorable conditions the ground wire will reduce the induced voltage to one-third of what is induced on unprotected lines under the same conditions. In fact, it appears that considerable protection is afforded even against direct strokes. Under ordinary conditions, say, fair or medium, it has been shown by laboratory experiments that a single wire will reduce the induced voltage to about 50 per cent of that without a ground wire; two wires to about 35 per cent; and three wires to about 24 per cent.

Insulation and Shielding

The general insulation of the line and its connected instruments is an important factor in lightning protection. The insulators must be of ample size and of approved design. The use of insulators of 100 per cent oversize is good practice, as they will stand quite an accumulation of soot and dirt without cleaning and will hold up in severe weather conditions, to say nothing of the high factor of safety in ordinary operation.

The inductive instruments, as the transformers, should have the highest possible insulation. If the lightning experienced is very severe, however, it is not always possible to provide sufficient insulation, particularly of the end turns.

Arresters

Arresters are of several general types; plain single or multiple gap, single or multiple gap with series resistance, and the so-called valve type, either mechanical or electrolytic. The plain gap type is now rarely used. Many of the second type are in use and they are convenient to use, as they can be made compact and are easy and convenient to install.

The most promising line of development appears to be in the valve type of arrester. In this type the valve breaks down at a certain critical voltage, after which there is very little resistance to the induced charge, which escapes very rapidly, after which the resistance is restored, cutting off the dynamic current. Until lately, however, this form of arrester had only been made in the electrolytic type, the use of which was largely confined to central station, as the film comprising the valve had to be maintained by an occasional charge, effected by closing the spark gap, and the electrolyte froze at moderately low temperatures.

There is one rule that must be generally followed and that is to place the arrester just as close to the instrument to be protected as is possible, a matter of inches making a large difference in the amount of protection afforded.

To go a step further would be to install choke coils in each transformer lead and in some cases this seems to work out satisfactorily, and their use is standard on some roads. The committee does not unqualifiedly recommend their use generally, however, as from some angles it seems foolish to put in an added choke coil when the transformer is much more effective in itself than any choke coil would be. Furthermore, a choke coil is unsightly and hard properly to insulate.

Underground Transmission Lines

Very few railroads have underground signal power lines and when these were first installed they were in some cases made up of rubber and braided wires or cables. A very small amount of leaded rubber, and in some cases paper, was used but such a small amount that no observations of value, as far as troubles from lightning are concerned have been made.

Several hundred miles of braided rubber has been installed, however, and many observations made. The wire was put underground to get away from all weather troubles and it was thought this would render it immune from lightning also, but this has not proved to be the case, as many punctures of the insulation have been made. In some localities the trouble has been serious, in others of no moment. How the high voltages get on the line, whether electro-magnetically or electro-statically, has never been determined, although a number of experts have studied the problem. It is the majority of opinion, however, that the trouble is electro-static and that it can be largely remedied if a lead sheathed cable is used. About 20 miles of lead sheath cable is now being installed in the place of some of the older installation but it will be some time before it can be determined whether or not the question has been solved. A portion of the lead cable has been in service about a year without any trouble occurring. In all cases where an overhead line is connected to an underground system, it should by all means be through an insulating transformer. This will at least keep lightning from entering through this avenue.

Third and Fourth Range Lines

What has been said concerning the fifth range lines holds generally true of the third and fourth ranges, the only difference being in the type of arrester. These lines (as high as 550 volts between conductors) are becoming numerous on account of the general introduction of the a.c. floating battery system and the question of the right kind of an arrester is becoming very important. This voltage range is a little bit high for a vacuum type of arrester and too low for the spark gap type, and the committee is at a loss as to what to recommend. It is probable that a modified vacuum arrester will be developed breaking down in the neighborhood of 700 volts. As a matter of fact, as it has virtually been agreed between various committees of the A.R.A. to allow of this type of line being placed on the lower cross-arm of existing communication lines, no lightning protection will be required as the lines above it will act as an efficient shield. It is only where the signal line is on top or on a separate pole line that lightning protection will be required.

First and Second Range Lines

These lines are generally made up of control circuits and lead directly to some rather delicate instrument, such as a relay, and the lightning protection consists almost entirely of placing an arrester between the line and ground, or in addition an arrester across the relay coils. Either arrangement is acceptable or one across the relay coils only is good and in some cases the best, as the ground connection, always troublesome, is dispensed with.

Many kinds of arresters are on the market; but these of the vacuum gap type or the gas-filled type are probably the best suited for these circuits, the breakdown voltage ranging from 250 to 400 volts.

Track Circuits

As a general rule, the only lightning protection needed for track circuits is required at the relay end and often even this is not necessary. There are certain types of relays,

however, particularly a.c. relays, which are very susceptible to lightning discharges. In these cases an arrester of the vaccum gap, gas-filled, or pin point type should be placed in multiple with the track windings. As a general rule this method of protection is entirely reliable.

Committee—C. H. Morrison (N. Y. N. H. & H.), chairman; L. F. Vieillard (L. I.), vice-chairman; T. N. Charles (Sou.), J. H. Deming (C. of G.), G. H. Dryden (B. & O.), W. F Follett (N. Y. N. H. & H.), E. N. Fox (B. & M.), C. E. Goings (Penna.), J. J. Larkin (S. B. R.), W. K. Saunders (R. F. & P.), and F. E. Wass (G. C. T.).

Discussion

C. H. Morrison (N. Y., N. H. & H), Chairman: In connection with the assignment of recommended voltage taps for rectifier transformers I would ask G. H. Dryden (B. & O.), chairman of the sub-committee, to make a progress statement.

G. H. Dryden (B. & O.): There are too many different methods of charging storage batteries by means of rectifiers. We are prepared to recommend voltage taps so far as it applies to the primary taps, but not so with the secondary taps on transformers. It is our recommendation, as stated in the reading of the Committee of Direction, that the subject for next year be some way broadened to include a specification for transformers, for rectifiers and also to prepare certain typical plans recommending just the construction for battery charging lines, using the a. c. floating battery system.

Chairman Post: This will be accepted as information.

Mr. Morrison: Since the report was submitted to the Signal section, Committee VIII has held a joint meeting with Committees IV and VII of the T. & T. section. It is the belief of Committee VIII that the T. & T. section was not familiar with the importance of the signal lines, and, therefore, there was not much headway made at the first meeting. After we had a joint meeting the T. & T. section seemed to have a better view of the situation and was more willing to go along with us.

Chairman Post: I think it is important ... gh to take a little time.

Mr. Morrison: At the joint committee meeting at New York on January 8, 1926, J. F. Caskey (L. V.), superintendent of telegraph, reviewed the subject. I tried to explain to the T. & T. section that the sudden loss of power due to grounds and interferences would result in the signals going to the stop position and causing sudden and unusual stops of trains, which might result in rear-end collisions.

In response to an inquiry as to the possibility of the Signal section using lower voltage for its circuits where joint construction is involved, the reply was made that owing to the wide separation of power supply sources it would be necessary to use the 4,400-volt circuits or use a larger size wire to transmit the lower voltages the necessary distance. The T. & T. section was very desirous to have the Signal section recommend 2,200 volts in lieu of 4,400 volts, due to their protective apparatus not being of a capacity that would protect their lines against the 4,400-volt charge.

The representatives of the T. & T. section stated that it was not the desire of the section to prohibit absolutely joint construction with signal power wires, but it believed it desirable to point out to the interested parties in the signal departments of the railroads the hazards involved, so that when considering joint construction of the type mentioned, all the features may be considered.

An informal conversation with the chairman of the T. & T. section leads us to hope that the matter will be brought to a conclusion that will be agreeable to all interests; however, Committee VIII would appreciate the views of this section in reference to the grounding of any part of a signal power transmission line.

Chairman Post: We would like to hear any discussion on this important subject.

Mr. Morrison: It is very expensive to the railroads to build independent lines and in some cases the right of way is so narrow that it is impossible to have independent lines. I believe the Western Union has given its consent to a 550-volt, 1,600-watt line on its poles, but there is nothing definite as yet determined between the T. & T. section and the Signal section.

B. T. Anderson (C. & O.): I would like to support the action that the committee has taken in this matter.

J. S. Gensheimer (Penna.): There are other possibilities from a grounded 4,400-volt line or transmission line, namely, the possibility of leaking currents, which we know interfere with train control, not only causing stop failures, but the possibility also of the other kind—clear failures. To my mind that is the most serious feature of this proposed scheme. I think Committee VIII is perfectly right in opposing any attempt to ground the signal transmission line.

G. H. Dryden (B. & O.): I think this specification has been introduced by the Wetsern Union Telegraph Company who was responsible for the drafting of the 1,600-watt specification. One of their men coming in contact with such wire, if it contains the neutral ground, will receive one-half its normal voltage to ground. They desire to reduce the hazard to that extent by using the grounded neutral. I oppose the neutral ground.

C. A. Dunham (G. N.): I would like to support the report of the committee, and I hope that the intentions of the committee will be carried out to a conclusion. We have been able to completely eliminate the oil lamp for signal purposes on our railroad, substituting, of course, electric lamps. I think that the committee ought to try hard to adhere to the plan of using one pole line.

O. R. Unger (Mo. P.): The Missouri Pacific is installing a 4,400-volt line, on top of our A. T. & T. lines and has also received permission from the Western Union in the last week to do likewise on its line. We installed an independent pole line with the exception of some points on the right of way where it is almost impossible to add another pole line.

The report on lightning protection was accepted as information and a *motion to accept the report on a. c. track circuits for submission to letter ballot, superseding subject matter in the Manual, was carried.*

[The committee was excused with the thanks of the Signal section.]

Lightning Protection on L. V. Lines

The subject of lightning protection was covered in an illustrated paper by Edward Beck, Westinghouse Electric & Manufacturing Company, which referred especially to the types of protective apparatus most suitable for the line voltages commonly employed in railway signal practice. To simplify the discussion of the problem Mr. Beck classified these latter voltages of transmission into three groups, namely: (1) Those higher than 550 volts; (2) those between 110 and 550 volts, and (3) those less than 110 volts. Over-voltages appearing on the last named group of circuits are a great deal more troublesome than the over-voltages appearing in the higher voltage circuits, largely because of the greater delicacy of the connecting apparatus. Dangerous voltage surges may be due to atmospheric discharges, either direct or induced, transients arising from sudden change in line conditions, induction from neighboring lines and direct crosses with high tension lines.

Some interesting data were included from a recent

investigation of over-voltages occurring on high tension transmission lines, conducted by means of a klydonograph, an instrument which makes a photographic record of high voltages. The highest surges have been due to actual lightning discharges, some of the direct strokes reaching values over 1,000,000 volts. The highest recorded voltage of an induced stroke was 900,000.

While this investigation did not lead to any conclusive results with respect to the utility of the overhead ground wire, it is evident, however, from data obtained on systems with and without ground wire protection that their installation has a beneficial influence. It was found that sheathed cables are less troubled with over-voltage surges than open lines. Although high voltages such as have been detected on high tension transmission lines are possibilities on low-voltage signal lines, the great majority of line disturbances occurring on lines used in signal practice are well below 50,000 volts.

Arresters for the protection of the 110 and 550-volt lines should be of the self-restoring type to prevent excessive power discharge. For this class of service the valve type of arrester possesses advantages because this arrester does not depend on the power current to interrupt the discharge. In concluding his paper Mr. Beck stated that the matter of earth connections should be given considerable attention, and that lightning arresters used for circuits operating at less than 110 volts should have a breakdown voltage as low as the operating voltage will permit, a minimum time lag, constant electrical characteristics and a long useful life.

Discussion

J. D. Jones (Penna.): There seems to be some difference of opinion in the construction of signal power transmission lines with respect to the use of A. C. on the ground wire. I would like to ask Mr. Beck's opinion of the value of the neutral wire in minimizing the effect of voltage on the power line.

Mr. Beck: That exerts a considerably beneficial effect on the induction from the power line. The electro-magnetic induction depends on the amount of flux which is originated in the transmission line. If you do not have a neutral wire, the unbalanced current flows through the transmission line and back through the ground. The current carrying loop is very large and gives rise to considerable magnetic flux. With a neutral wire, the bulk of the current, instead of passing through the ground, will go back through the neutral wire. The flux originated will be very much less, and in that way the electro-magnetic induction is reduced as well as the electrostatic induction. If I remember rightly, I think I have seen some figures on tests made on certain telephone systems in which the disturbance to telephone conversation was reduced to 30 per cent what it was before the use of the neutral ground wire.

J. S. Gensheimer (Penna.): Do we get much benefit from lightning itself by the overhead ground wire, or could we get more protection for our money by the use of more arresters?

Mr. Beck: If you have a good ground wire installation, the over-voltage may be reduced to 40 or 50 per cent of the voltage which would appear in the system if you did not have a ground wire. I do not think you could eliminate the lightning arresters by using the ground wire, but you can improve considerably the protection by installing the ground wire.

Mr. Gensheimer: Could we add more lightning arresters than we usually put in, and get as good or better protection than by the installation of the ground wire?

Mr. Beck: I cannot say as to whether that would be true or not, but if you put in five arresters per mile, the danger from over-voltage would be considerably reduced, because with such a density, the surges could get to ground easily. I don't think that you would get away from all your trouble, however.

Mr. Gensheimer: On one division where I was located, we had a 4,400-volt, 60-cycle line, 58 miles in length. At the interlockings, within a distance of about 1,500 to 2,000 ft., there were three transformers, each transformer being protected with lightning arresters. Outside of the interlocking limits, the arresters were located approximately a mile apart. I can't recall having any lightning trouble, where we had those three sets of arresters so close together, all of our troubles were on the automatic section, where the arresters were approximately one mile apart. It occurred to me that possibly by putting in another set of arresters at the automatic signals adjacent to the transformer we might eliminate most of our lightning trouble at the automatic signal.

Mr. Beck: In a case like that it would be a good deal cheaper to put in a few more lightning arresters than to put up a ground wire. Of course, just one ground wire alone exerts a beneficial effect, but it does not exert the effect that several ground wires would. If you have a metallic sheathed cable where the conductors are entirely surrounded by a grounded conductor, the difficulties from lightning are practically eliminated. If you put up several ground wires you can reduce the voltage a considerable amount, but it is cheaper to put up a few more arresters than it is to put up more ground wires.

Signal Section Elects Officers

AT the closing session of the convention of the Signal section, A. R. A., at the Drake hotel yesterday, officers were elected for the coming year. A. H. McKeen, signal engineer of the Union Pacific System, Omaha, Neb., was elected chairman; C. H. Tillett, signal engineer of the Canadian National Railways, Central region, Toronto, Ont., was elected first vice-chairman, and C. F. Stoltz, signal engineer of the Cleveland, Cincinnati, Chicago & St. Louis, Cincinnati, Ohio, was elected second vice-chairman. Mr. McKeen has been active in the Signal section for several years and his election is considered an evidence of his good work in the different committees. Mr. McKeen was born on November 13, 1879, at Oakland, Cal. He entered railway service in April, 1895, as a signalman on the

A. H. McKeen

Southern Pacific. In November, 1900, he was appointed supervisor of the Sacramento division and in 1903 was transferred to the Coast division. Mr. McKeen was appointed signal engineer of the Oregon-Washington Railroad & Navigation Co. and the Southern Pacific lines in Oregon in June, 1905. On April 1, 1920, Mr. McKeen was promoted to signal engineer of the Union Pacific.

Registration of Signal Section Reaches 430

A TOTAL of 80 members and guests registered at the meeting of the Signal section, of the A. R. A., at the Drake hotel yesterday. With the 350 who registered on Monday, the total was 430. This compares with a total registration of 450 last year.

Representatives

Abernethy, H. D., gen. sig. inspr., N. Y. C., Cleveland O.
Ambach, E. T., asst. sig. engr., B. & O., Cincinnati, O.
Anderson, A. H., sig. supr., C. B. & Q., Alliance, Nebr.
Ashley, R. D., sig. inspr., I. C., Chicago.
Bender, F. W., sig. engr., C. R. R. of N. J., Elizabeth, N. J.
Bousquet, E. N., asst. sig. supr., N. Y. C., Toledo, O.
Burns, H. E., asst. sig. supr., G. T. W., Valparaiso, Ind.
Christein, Nels, sig. supr., C. C. C. & St. L., Urbana, Ill.
Clark, A. C., asst. to sig. engr., Erie, New York.
Coleman, J. P., sig. supr., G. T. W., Durand, Mich.
Combs, H., supr. sigs., N. Y. C. & St. L., Tipton, Ind.
Cook, W. F., asst. supr. sigs., D. & H., Plattsburg, N. Y.
Dahlstrom, H. R., sig. supr., U. P., Cheyenne, Wyo.
Dayton, W. L., supr. sigs., G. T. W., Battle Creek, Mich.
Dryden, H. M., sig. supr., B. & O., Dayton, O.
Fereday, F. T., gen. sig. for., L. & N., Louisville, Ky.
Finch, J. C., sig. inspr., M. P., St. Louis, Mo.
Ford, F. A., supr. sigs., C. & O., Clifton Forge, Va.
Foster, F. C., sig. supr., L. & N., Evansville, Ind.
Giffin, T. E., tel. & telg. insp., Penna., Chicago.
Haney, F. E., sig. supr., C. R. I. & P., Topeka, Kans.
Hemphill, F. J., sig. supr., C. R. I. & P., Trenton, Mo.
Hoffman, S. C., supr. sigs., I. C., Champaign, Ill.
Keller, S. B., sig. supr., B. & O., Wheeling, W. Va.
Killingsworth, J. J., supr. sigs., C. N., Stratford, Ont., Can.
Kinney, F. E., asst. sig. supr., C. R. I. & P., Cedar Rapids, Ia.
Kipp, W. E., sig. supr., C. & O., Covington, Ky.
Kydd, G. W., sig. pilot engr., B. & O., Baltimore, Md.
Lewis, E. H., supr. sigs., C. N., Quebec, Que., Can.
Miller, W. H., sig. inspr., C. & O., Huntington, W. Va.
Neal, G. P., sig. inspr., C. & E. I., Chicago.
Newbegin, P. C., maint. engr., B. & A., Houlton, Me.
Orr, H. H., sig. engr., C. & E. I., Chicago.
Penrod, A. J., Jr., sig. supr., B. & O., Wilmington, Del.
Persinger, Charles, sig. inspr., C. & O., Hinton, W. Va.
Prinn, B. H., sig. supr., B. & O., Baltimore, Md.
Rex, C. D., chf. sig. & elec. inspr., Southern, Cincinnati, O.
Richards, D. W., sig. engr., N. & W., Roanoke, Va.
Ryan, F. J., supr. sigs., I. C., Freeport, Ill.
Sheets, R. A., asst. engr. train con., C. & N. W., Chicago.
Slater, E. G., sig. supr., B. & O., Chillicothe, O.
Smith, C., sig. inspr., St. L.-S. F., Springfield, Mo.
Smith, L. W., asst. sig. engr., C. M. & St. P., Tacoma, Wash.
Swanson, W. W., sig. supr., C. B. & Q., McCook, Nebr.
Thompson, S. R., sig. supr., C. & O., Huntington, W. Va.
Wesson, E. G., off. engr., C. B. & Q., Chicago.
Whitcomb, L. L., sig. supr., N. Y. C., Cleveland, O.
Wright, J. T., supr. sigs., G. T. W., Detroit, Mich.
Wyant, Leroy, actg. sig. engr., C. R. I. & P., Chicago.

Railroad Affiliated Members

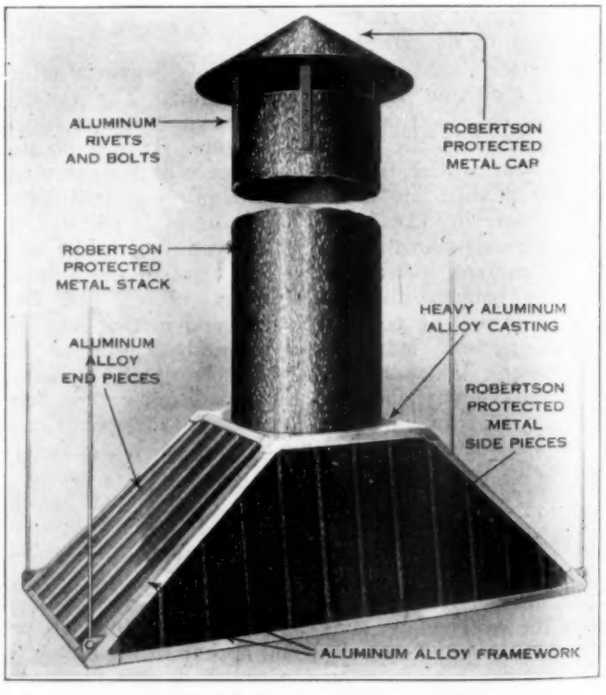
Anderson, F. L., sig. maintr., A. T. & S. F., Winfield, Kans.
Ashford, S. D., sr. sig. engr., Interstate Commerce Commission, Washington, D. C.
Hastings, E. M., chf. engr. R. F. & P., Richmond, Va.
Ramsey, T. B., sig. insp., C. & O., Huntington, W. Va.
Rentschler, H. W., supr. sigs., Reading Co., Reading, Pa.
Ross, R., supr. sigs., c/o P. M., Grand Rapids, Mich.
Yewell, J. E., chf. drafts., B. & L. E., Greenville, Pa.

Affiliated Members

Anderson, A. S., vice-pres., Adams & Westlake Co., Chicago.
Coleman, J. P., cons. engr., Union Switch & Signal Co.
Everett, E. A., Railroad & Signal Appliances, Long Island City, N. Y.
Hackett, J. W., sales engr., The Okonite Co., New York.
Hunter, F. M., salesman, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.
Jones, W. A., mgr. ry. sales, Standard Oil Co., Chicago.
Kendrick, R. S., asst. ed. *Railway Signaling.*
Kyle, W. T., gen. mgr. sales, Page Steel & Wire Co., Bridgeport, Conn.
Loucks, J. L., sales engr., Union Switch & Signal Co.
Mann, L. R., sales engr., Okonite Co., St. Louis, Mo.
McNeil, E. H., sales engr., Okonite Co., Chicago.
Pendorf, P. G., sales engr., National Carbon Co. & Prest-O-Lite Co., Inc., East Orange, N. J.
Prescott, C. W., engr., General Railway Signal Co.
Reeb, C. A., sales rep., Kerite Insulated Wire and Cable Co.
Rees, M. D., sales engr., National Carbon Co., Chicago.
Schermerhorn, E. F., sales engr., Rail Joint Co., New York.
Simmen, P. J., pres., Simmen Automatic Railway Signal Co., Eden, N. Y.
Sperry, H. M., pub. rep., U. S. & S. Co., H. S. & S. Co. and G. R. S. Co., New York.
Stallknecht, F. S., sales engr., Thomas A. Edison, Inc., Bloomfield, N. J.
Strickler, J. M., mgr., track mat. sales, Ohio Brass Co., Mansfield, O.
Underhill, J. D., sales mgr., The Okonite Co., Passaic, N. J.
VanSteenburgh, W. R., sales engr., The Okonite Co., New York.
Williamson, A. G., sig. engr., Pittsburgh Train Control Co., Pittsburgh, Pa.
Wilson, D. C., sales mgr., Edison Storage Battery, Orange, N. J.

A New Protected Metal Smoke Jack

A NEW smoke jack, embodying the use of Robertson protected metal in several details and an aluminum alloy in others to give reduced weight, has been developed by the H. H. Robertson Company, Pittsburgh, Pa. This smoke jack is designed to be durable, light in weight, easily erected and not to require unduly heavy roof construction for its support. The steel core of the protected metal parts is covered by three impervious coatings of as-


ALUMINUM RIVETS AND BOLTS
ROBERTSON PROTECTED METAL CAP
ROBERTSON PROTECTED METAL STACK
HEAVY ALUMINUM ALLOY CASTING
ALUMINUM ALLOY END PIECES
ROBERTSON PROTECTED METAL SIDE PIECES
ALUMINUM ALLOY FRAMEWORK

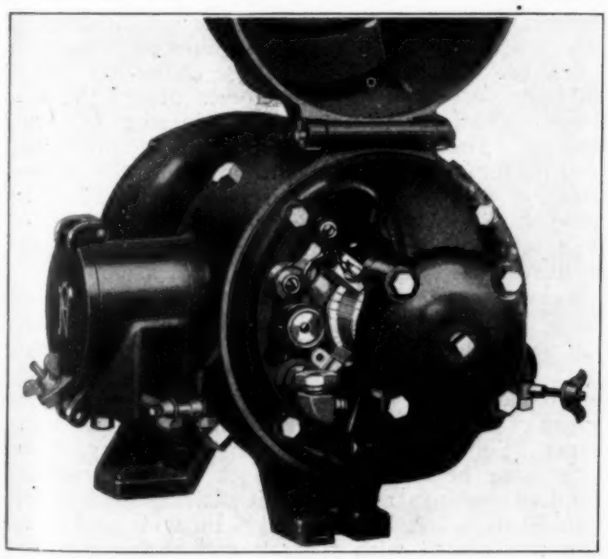
Smoke Jack Built of Robertson Protected Metal and an Aluminum Alloy

phalt, asbestos felt and a heavy waterproofing envelope, tending to produce enduring qualities under severe corrosion conditions. In assembling the smoke jack, provision has been made for putting the various parts together with a minimum number of bolts and nuts and where bolts and nuts are used they are made of aluminum.

As shown in the illustration, the stack and cap of the smoke jack are made of Robertson protected metal as are also the side panels of the hood. The end panels of the hood are composed of sheets made of an aluminum alloy. The piece over which the stack fits and which joins the stack to the hood below is a heavy aluminum casting, secured to the panels of the hood by an arrangement which eliminates the necessity for bolts and nuts. The entire framework of the hood is made of aluminum alloy castings. An idea of the light weight of the Robertson smoke jack may be gained from the fact that the standard 36-in. stack weighs about 300 lbs.

Turbo-Generator Designed for Train Control Application

THE requirements of modern train control have created a number of new conditions to be met by turbo-generator design. For the combined service of locomotive headlighting and power supply to the train control apparatus new standards of performance are required. In the operation of train control systems, either of the continuous or intermittent types, the important feature of a smooth wave and unvarying direct current supply for the filament, dynamotor and inductor circuits should receive primary consideration. Alternating current in these circuits may introduce a potential failure of the train control. The existence of an a.c. supply in the amplifier circuit may introduce an overload or parasitic

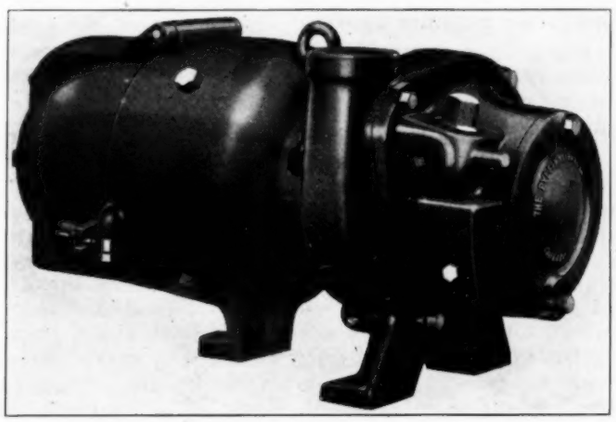


End View of Pyle-National Small Turbo-Generator Unit

loading of the vacuum tubes with a probable failure of the train control. A two or four-pole generator with a ring wound or lap wound armature contributes to the undesirable possibilities due to the inherent characteristics of these types.

With the belief that no adaptation of a standard headlighting generator would be satisfactory for train control service, the Pyle-National Company designed a special unit for this service. The Type E-3 turbo-generator was the first machine on the market which was built specifically to meet train control requirements. It was designed to give a perfectly smooth, flat voltage wave form, and to retain its special characteristics throughout its entire service life. These machines, of which there is a number now in operation, have given satisfactory service.

Based upon operating experience with the Type E-3 unit, and in response to a definite demand for a smaller machine, the Pyle-National Company has designed the



Side View of New Type MO-6 Turbo-Generator Designed for Train Control Application

new Type MO-6 turbo-generator for combined headlighting and train control service. This machine weighs 185 lbs., and because of its size, the new design of the unit is said to be easier to handle and to maintain than other machines. The Type MO-6 retains all the distinctive features of the Type E-3 turbo-generator in a slightly smaller machine. It provides ample capacity for locomotive lighting and, in addition, ample capacity for all the requirements of either the continuous or intermittent types of train control.

Simplicity in design has been given particular attention in the production of the Type MO-6 unit. As example, the ball-bearings in each end are duplicates, thus requiring but one type of repair stock, and the entire bearing mounting has been made unusually accessible. The brush ring is a bakelite with lugs for locating its position in the yoke. The brushes and rigging can be removed as a unit, and replaced quickly and easily without any possibility of altering the brush position. It is claimed that the new machine has fewer parts than others now available and is arranged to simplify all maintenance operations and to reduce the number of parts required for repair stock. The turbine end of the Type MO-6 is similar to that of the Pyle-National Type M turbo-generators of larger capacities. The governor is of the same design (mounted as a unit) as that used in the Type-M machines for train lighting service. The water rate of the Type MO-6 turbine is claimed to be very low.

This MO-6 generator is a four-pole machine with an improved type of field coils. The armature is wave form wound and four brushes are provided, although two would suffice. This extra set of brushes is said to insure perfect commutation. Either one or two of these brushes can be lifted without causing any change in the operating characteristics of the unit. Since the machine has four poles with a wave form wound armature, and operates at 3,400 r.p.m., alter-

nating current output is said to be definitely excluded. The voltage wave under all conditions of operation is flat and smooth, without a trace of alternating current. An important feature of the turbo-generator is the fact that the perfect voltage wave form will be retained throughout the entire service life of the machine. Alternating current is excluded by the inherent characteristics of the generator, and normal wear of the unit in service will not affect the performance. Some types of generators tend towards undesirable output as the unit wears in service, and the maker claims that the security of the special MO-6 generator design will be more fully appreciated as this factor becomes apparent during service life.

Zenith Reinforced Shovel

THE weak points in shovel construction are the D; the point where the handle is inserted in the top of the straps, or socket; and the point where the blade is riveted or welded to the shovel straps. With the idea of obtaining greater strength at these weak points the Zenith Shovel Company, Chicago, has developed a shovel with a "backbone" of steel in a handle of specially-selected, northern-grown white ash. The steel blade is carefully Brinnelled to assure the correct hardness in combination with toughness. A turn-over flare at the top gives the blade I-beam strength, while at the same time acting as a step to save wear on shoes. As stated, the handle is reinforced with a steel "backbone," a ferrule also of steel being compressed cold into a groove in the handle where it fits in the socket and gives added strength to the assembly. The D is made of 18 gage tubular pressed steel, the grain of the wood grip running lengthwise, and the grip being cupped at the ends and securely riveted off center. The wood

New Shovel, Which Has a "Backbone" of Steel

grip cannot turn, and the proportions of the D are such as to give a roomy, comfortable hold on this end of the shovel. The blade and socket of the shovel are in one piece, shaped from a single sheet, the socket therefore being of the same gage as the blade except at the extreme end where it is rolled tapering to fit the handle smoothly. The shovel is of well-balanced design, with a comfortable hand grip on the socket, and tested to a load of 175 lb. It is made in only one size, No. 2, with either a square or round point.

A New Protective Coating for Steel

A NEW asphalt protective coating which can be deposited on steel, concrete, wood, etc., without the aid of heat or asphalt solvents, has been developed by J. B. W. Gardiner, Inc., 50 Church street, New York, and is called Hydralt. It is already in use on a number of American as well as some foreign roads, being employed for the protection of steel against locomotive gases in train sheds, roundhouses and on viaducts. It is also used for coal car

Section of Bridge on Which Standard Coatings Disintegrated in Less Than 30 Days

lining; the protection of bridge floors from refrigerator car brine drippings; on transfer bridges; as a damp proofing material for use on masonry; and as a roof maintenance coating.

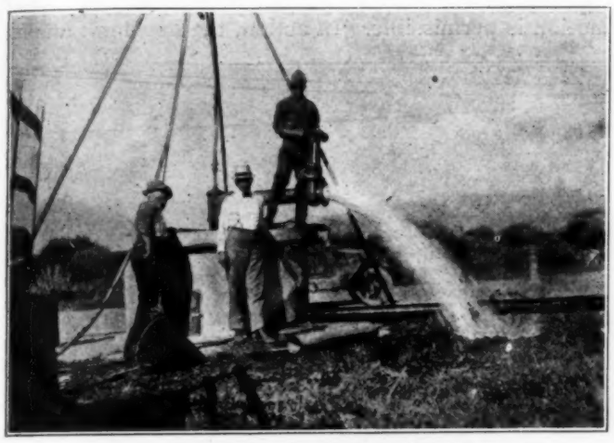
Water, used in the preparation of Hydralt, is the vehicle by means of which the asphalt may be spread cold, thus affording three marked advantages over hot asphalt. The first is simplicity of application, a whitewash brush and a pail of water constituting the only equipment required. It may likewise be sprayed if desired. The second advantage claimed is that it will bond perfectly to cold steel even though the steel is wet. Third, it will not seep, nor bleed at any temperature. The process by which it is made practically destroys its fusibility after setting so that the seeping action of hot asphalt is entirely absent. This fact makes it possible to use a very low melting point asphalt with the advantage of flexibility at low temperatures that is characteristic of such asphalt.

Many interesting tests have been made of Hydralt, one of the most conclusive of which was in connection with transfer bridge No. 2 of the Erie at Jersey City. The water at the foot of this bridge, in addition to being salt, is peculiarly foul and corrosive by reason of discharges into it from many manufacturing plants. Some idea of the corrosive activity of the water may be had from the fact that many of the standard coatings applied to it disintegrated in less than 30 days. A bar of steel 6 in. wide and 18 in. long was coated with Hydralt and anchored to the free end of this bridge so that whenever the bridge dipped from the weight of a car, the bar went into the water with it. As this was a point of great traffic density, the bar was in and out of this water almost hourly over the entire test period. The bar was first examined at the end of six months and on removal of the scum and slime deposits, the coating was found to be in perfect condition and the steel and rivet entirely free from rust. The bar was then put back on

the bridge and inspected again at the end of another six months, when there was still no sign of disintegration of the coating or corrosion of the metal.

Air Lift "Air Made" Well

THERE are many localities, particularly in the central and south west, in which excellent supplies of underground water are available at depths of 100 to 200 ft. below the surface. These supplies, found in sand or gravel beds, have frequently been neglected and passed by, in favor of much deeper



Flow After "Air Making" and Cleaning by Pressure

water strata on account of the difficulty of keeping the mechanical pumps in order when wells have been bottomed in these strata.

As is well known, the action of sand and gravel in these wells creates rapid wear on the moving parts of pumping equipment, necessitating frequent adjustment or replacement. Moreover, the capacity of the well falls off rapidly on account of "sanding in," and in addition, it is frequently necessary to establish settling basins for the fine sand which comes through the pumps, in order to remove it before the water is pumped into the supply tank.

The "Air made" well illustrated, is a modification of the Sullivan air lift system, with no working valves, plungers, impellers, bearings, pump rods, or other moving parts to be cut out or worn by the action of sand and gravel. The air lift, furthermore, maintains its original operating efficiency at all times. "Air made" wells are said to be long lived, because the screens cannot pack; the gravel around the screens cannot become tight; and more coarse gravel is always being forced into them, and the finer material removed.

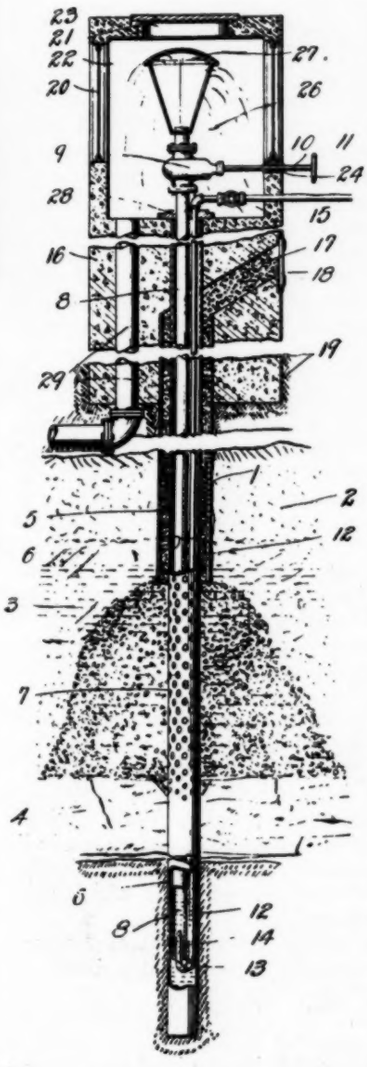
The principle of the "air made" well consists in back blowing or reversing the normal flow of air and water in the well, so that the fine sands are pumped out, and by the same action, coarse gravel, where this exists in the strata, is pulled in around the strainer. When coarse gravel does not occur, the following method is adopted. A large chamber is provided around the well casing, connected at the top with a passage, down which coarse screened gravel is poured. As the fine material is pumped out, this coarse gravel keeps on working down into the space left free for it, until a gravel bed is provided outside the strainer, the result being shown by the accompanying illustration.

The screen used in "Air made" wells is not designed to hold the fine materials out of the well; in fact, it is designed to permit fine materials to flow with the water into the well, thus eliminating the packing of these fine materials in the gravels surrounding the well.

The gravel used around the perforated section is not a filter of coarse and fine gravel mixed, used to keep the fine sands and silts from flowing toward the well with the moving water. This gravel is all heavy, coarse material, and is used to support the sides and top of the well formation. Any fine sand or silt coming into this gravel near the well is drawn into the well itself, thus keeping the coarse gravel open and permitting a free flow of water into the well.

The magazine is so designed that gravel constantly feeds into the well around the perforations as the fine materials are removed. This magazine is so arranged that it can be recharged at any time with little trouble.

By means of the back pressure valve, "Air made" wells can be cleaned at any time by merely closing



1. Sheath Tube.
2. Upper beds, sand, clay and silts.
3. Water bearing beds, sand, gravel or silts.
4. Bed rock or bed clay or shale.
5. Coarse gravel placed in water bearing beds.
6. Inner tube.
7. Perforated section of inner tube.
8. Discharge water line.
9. Valve regulating back pressure.
10. Extended stem for back pressure valve.
11. Removable hand wheel operating valve.
12. Air line.
13. Water intake to air pump.
14. Standard air pump.
15. Air regulating valve.
16. Reinforced concrete used in well head.
17. Gravel magazine in concrete well head.
18. Cast iron door closing magazine.
19. Concrete footing around well.
20. Plate glass in sides of well head.
21. Cast iron manhole ring.
22. Cast iron frame holding plate glass.
23. Cast iron manhole cover.
24. Stuffing box through concrete.
26. Discharge opening.
27. Umbrella separator.
28. Flange sealing well.
29. Discharge water line to surface storage.

Applications for patents have been filed.

Detailed Construction of "Air Made" Well

and opening the one valve. This cleaning not only clears the perforated section but clears the gravel deposit itself, and at the same time forces more large gravel from the magazine into the well under pressure.

A well in Northern Kansas, constructed according to these principles, was producing about 200 gal. per min. when first constructed. However, after fine sands

and silts were removed, and coarse gravel poured into place under pressure, this same well, six months later, increased its yield to 419 gal. per min. and this performance has been maintained since, without diminution of flow.

New Magneto Drive for Locomotive Tachometer

A NEW form of magneto drive has been developed recently by the Electric Tachometer Company, Philadelphia, Pa., in conjunction with the Westinghouse Electric & Manufacturing Company for the application of electric speed indicators to locomotives, independent of train control or other apparatus. This new drive permits the installation of an electric tachometer outfit in a few minutes' time, and eliminates the use of special gears, pulleys or belts.

As the function of a tachometer in railway service is to indicate train speed to the engineman, the indicator must be accurate and easily read at a glance. The tachometer must be so constructed and protected that it is not affected by severe vibrations, changes in temperature, dirt, water, ice or steam. From the maintenance point of view, a tachometer must be interchangeable, and easy to install on new or old equipment. It must be of rugged construction to stand the knocks of service, and must require a minimum amount of repair. Adjustments should be accessible for easy manipulation, but the tachometer must hold its calibration permanently, after adjustments have been made.

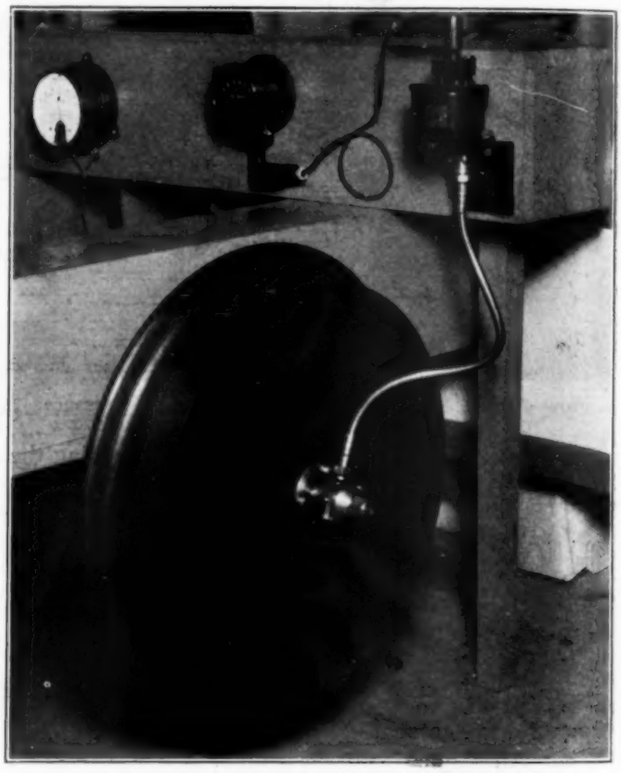
The electric tachometer, in its simplest form, consists of a magneto-generator driven from one of the locomotive wheels and an indicator located in the cab. The magneto and indicator are connected electrically, and are calibrated together to insure the highest degree of accuracy. Every speed of the magneto corresponds to a definite number of miles per hour on the dial in the cab. The magneto is a direct current generator of the permanent magnet type. The frame, of heavy construction, is water and steam proof. The armature runs in ball bearings which are accessible for oiling and inspection. Perfect contact at the commutator is claimed by the use of 14 karat gold for commutator bars.

The indicating instrument has an open scale which is easy to read and non-shattering glass is used over the dial. The cast bronze case is dirt and steam proof. The indicator element is a direct current voltmeter of the D'Arsonval type, constructed to withstand vibration. It is possible to connect two or more indicators to the same magneto. This is especially desirable in the case of electric locomotives which may be operated from either end.

When the diameter of the locomotive wheel changes, due to wear or replacement, it sometimes becomes necessary to make corresponding changes in the calibration of tachometers. The electric tachometer circuit contains a small rheostat located in the base of the indicator, access to which is obtained by removing a small cap screw. Adjustments can be made directly at the indicator in full view of the dial.

The outstanding feature of the new design is the method of driving the magneto from the locomotive wheel. Formerly it has been necessary to use special gears or a belt for this purpose. The new drive, it is said, eliminates the use of special attachments and also eliminates the possibility of lost motion in a slipping belt. This equipment can be attached to any locomotive easily by the use of ordinary hand tools.

The magneto is mounted (with shaft vertical) on the framework above or adjacent to one of the leading wheels of the locomotive. A small gear box is attached to the end of the locomotive axle, outside of the wheel. Only three small tapped holes in the axle are necessary for mounting. A short length of flexible shaft connects the gear box to the magneto. The gear box contains a pair of bevel gears, one being rigidly attached to the locomotive axle, and the other in a housing which is free to revolve around the first bevel gear as a center. The flexible shaft is attached to the second bevel gear and prevents actual rotation of the housing, although a small amount of motion is permissible. In action, the housing remains



Simplicity and Ease of Installation Are Claimed for This Magneto Drive

stationary and the gears revolve, transmitting motion through an angle of 90 deg. to the flexible shaft and magneto. This construction it is said reduces the transmission problem to its simplest form and takes care of all movements of the locomotive wheels with respect to the locomotive frame. It allows the magneto to be mounted rigidly, as its heavy construction requires, and at the same time provides a positive drive which is independent of various wheel positions

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Wood Preserver Leaves—C. Marshall Taylor, superintendent of the Port Reading Creosoting plant of the Reading Company and the Central Railroad of New Jersey, at Port Reading, N. J., has resigned to become general manager of the Sharples Solvents Corporation, a company recently formed and now building a plant at Charleston, W. V., to manufacture light alcohols for the lacquer industry. Mr. Taylor has long been active in the wood preservation industry, having served as chairman of the Committee on Wood Preservation of the American Railway Engineering Association in 1919, 1920, 1921, 1922 and 1923.